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THE FLABELLID AND TURBINOLID
CORALS

BY

J. STANLEY GARDINER, F.R.S., AND PEGGY WAUGH

WITH SEVEN PLATES AND SIX TEXT-FIGURES



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J. STANLEY GARDINER, F.R.S., AND PEGGY WAUGH*

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I. PREFACE.

THE collection of corals obtained by the John Murray Expedition only differs from that of most former expeditions in that it will be possible subsequently to determine with some accuracy the nature of the ground, on which the corals dwelt, and the character of the water, from which they obtained their food. It will be seen that the collection now described contains relatively few species. This is largely due to the fact that dredge, trawl or grab, when it reached the deck, if it contained any corals at all, was found usually to have captured a large number generally of one or a very few species. There were different stages of growth, though in most cases the majority were adult. A study of such a series enables the worker to determine the variation of the species in all its characters. These corals all show great vegetative variation, but yet there would seem to be groups of individuals which are gametically separated from all other groups. The recognition of

* Miss Waugh made an extensive examination of the following genera, tabulating and measuring every specimen: *Stephanocyathus*, *Paracyathus* and *Deltocyathus*.

vegetative variations is, of course, inimical to species-formation by authors, unless, as Cuvier is stated to have done, embarrassing specimens are destroyed. Species founded on single, very few or dead specimens, chemically altered, had better be ignored unless available for re-examination, for which they might be lent as the Director of the Museum at Oslo lent us the unique *Fungiacyathus* of Sars. The Director of the British Museum was also as helpful as his rules allow, but "types" are not lent; it would be to the advantage of science if he and his Keepers could be given discretion in this matter. In particular, we desired to see Duncan's types, but numerous inquiries both in England and in the United States gave us no information as to their whereabouts.* Unlabelled specimens and drawings in old plates are valueless for the identification of species.

II. INTRODUCTION.

The old family Turbinolidæ form a group of solitary corals extending from the Lias to the present day. Most genera and species are fossil—and most species are founded on single or few specimens. Of living species, we are generally informed that they were collected at a certain depth by an expedition; occasionally we know the nature of the bottom on which they were living, but this is exceptional. With fossil forms it is rare to find any attempt to reconstruct their former environment. The chief home of the group to-day is at a depth greater than 50 fathoms, but at times species may be found in shallower waters—and one genus, *Heterocyathus*, which is usually associated with an *Aspidosiphon*, is essentially a shallow-water form. As to temperature the main fall is at about 50 fathoms, and, if there is any restriction here, it is one of higher temperature. Lastly, there is no association of these corals with symbiotic algæ as yet definitely known.†

To determine genera there is shape, discoid or upright, calicle round, oval or compressed, with base any size between a point and a broad base of attachment, this and the whole column even having a breadth equal to that of the calicle; lastly, the whole coral sometimes free or unattached. The wall may be a true epitheca, formed from inside by coral deposition outside the polyp-wall, this character giving the family Flabellidæ.‡ For the rest, in the Turbinolidæ the wall is a theca formed by depositions between neighbouring septa, these meeting and fusing; the plate outside this wall is termed the costa and that inside the septum. It follows that costæ are always present with a thecal wall, but the polyp in its retreat up the outside of the coral skeleton may fill in the spaces between neighbouring costæ, as it were continuing its basal plate up the sides of the coral; the corallum thus deposited has a tendency to be rather shiny and is epithecal.

The edges of septa and costæ may end in teeth and an inner tooth of a septum may be large, perhaps elongated, the whole somewhat thickened. Often a circle of columns lies in front of certain septa, only connected to the same by later formed, thin trabeculæ of corallum and not parts of the septa; these are sometimes hard to distinguish from septal teeth and are the pali.

If pali are present, there is usually a columella, but the reverse is not the case. The presence or absence of pali and columella are generic characters, and often the character

* This is particularly unfortunate in respect to *Conocyathus*, for it is on Duncan's authority that this is to be recognized as a living genus (*vide* 'Proc. Zool. Soc.' 1876, 431).

† *Cp.* 'Brit. Mus., Terra Nova Exp.' V, 129 (1929).

‡ *Cp.* Vaughan, 'U.S. Nat. Mus., Bull. 59, 48 (1907).

of the columella is also important, a single or several rods, a plate, twisted ribbons or merely processes of corallum arising from the base and joined below to the septal ends, forming by fusion together a kind of sponge-work. In all cases, deep down in the corallum, septa, pali and columella are usually connected by trabeculae, narrow threads of corallum of later formation.

The septa in all cases appear to arise as a circle of six vertical plates, then a further 6, 12, 24, etc., and thus cycles I, II, III, IV, etc. Three to five cycles usually form the regular number, 24, 48 and 96 septa, but different numbers are found within many genera, so that they are of little use in the classification of genera—and the same remark applies to the number of pali, which may lie before I, II, III or IV, often before two of these. Generally 6 (I) or 12 (I and II) septa are broader, thicker and rise higher than others, and commonly between them lie three septa (II and two of III, or III and two of IV), so that the septal system seems in groups of 4. The extraordinarily uniform commencing group of 6 is often disturbed in later life, especially in compressed calicles, where there is need for more groups of 4, the septa of each group and of the groups themselves being equidistant from one another. Thus may appear septa characterized, in the terms of the above hexamery, as belonging to a cycle not usually present, whereas in reality it is generally the formation of an additional 4-group; here pali also form before the appropriate septa. In a compressed calicle, if more 4-groups are wanted, there should be 2 at each end—and this is frequently the case where the largest septa number 12, thus giving 16 septa, to which may be added pali of equal number, if pali are present in the species. This is especially well marked in *Caryophyllia*, but here there is one little compressed species below* with 8 larger septa and pali, whereas there ought to be 10 if two groups of 4 are added symmetrically. Ten septa is a common phase in growth-number, the different cycles of septa arising at different heights within the coral as it grows upwards, but it is never an adult feature, while 8 is not rare.

Of specific characters, other than those referred to above, there are few of value. Indeed, corals especially, and to some degree all true, fixed, sedentary animals, are unhappy in this respect. Their feeding is mechanical, swallowing aided by tentacles and peristome forcing the food into the stomodæum and ciliary currents leading into the same. They further have no power of movement. Thus are eliminated all organs of feeding and movement, which so greatly aid in specific identification in free-living animals, which have the power of choosing their food and the means of finding it.

Then there is the shape, whether free or fixed, cone or broad base, or a disc—this often generic. It will be seen later that in *Deltocyathus* we think the coralla never were fixed,† the whole skeleton growing within the polyp, thus differing from *Fungia*, the mode of dehiscence of which pervades all ideas of discoid corals. In many cases the original point of attachment was minute, and the freedom later attained is frequently due to upright growth and a subsequent detachment due to the mechanical factor of weight. Where the coral is attached to rock it grows at right angles to the same, and where free it desires apparently to present its mouth and oral disc parallel to the bottom, thus escaping mud and rising above the motionless layer of water—a possible exception here being *Flabellum*. A disc is easy, but an upright coral can only attain this position by growing in a curve if it becomes free; in this respect our series of free-living species of

* *Vide C. mabahithi* n. sp., p. 178.

† *Vide* p. 195.

Caryophyllia,* all lying on muddy grounds, is important. However, we may be indulging in a false generalization.

If polyps of a reef-living species of coral are damaged, almost the smallest part will regenerate the polyp and hence its corallum. The forms, however, that one of us experimented with at Minikoi were mostly colonial, which introduces a complication, but *Fungia* regenerated well, though requiring a reasonable piece, preferably a sector from its centre. Here, in our collection, are many examples of regeneration, and we are led to the opinion that one group of the "colonial" Turbinolidæ are really due to a peculiar form of this (*vide* p. 182). Upright growing coralla often show breakages and regeneration of parts, outgrowths which give rise to new calices, perhaps inside the original calices. Thus almost any shape may result, but the regenerated corallum always tries to assume the shape characteristic of its genus (*cp.* *Tropidocyathus nascornatus* n. sp., p. 193). In all the above the need for regeneration may be caused by an accident, but in the species referred to this seems impossible. In some discoid corals of which the discoid *Diaseris*-group of *Fungia* has been especially studied, this is clearly not the case.† Nor can it be deemed to be in *Fungiacyathus* and perhaps other forms.

These considerations all point to the need for a revision of these solitary corals. Vaughan and Wells circulated a list of genera of Turbinolidæ some years ago showing their ideas as to these. We trust that some day they will publish their views. Only thus by a combination of specialization in and study of living and fossil forms together, such as these authors offer, can any measure of finality be attained. The student of living forms is confronted with chemical changes which are embarrassing, viz. a possible change from aragonite to calcite, and always a certain thickening of septa and all parts of the skeleton by an opaque surface deposition of calcium carbonate, a phenomenon common also in living corals after death. Further, epitheca is ill-defined between geologists and zoologists, the latter regarding the epitheca, of which the basal disc is part in development, as deposited from one side (the inner side) only, whereas all other parts grow up with corallum being deposited on both sides.‡

III. ON GENERA FROM THE WEST INDIES.

Dr. Thomas Barbour, Director of Agassiz Museum, Harvard, most generously sent us specimens of many of the species of corals described by Count L. F. de Pourtales and described in the publications of his Museum. One series arrived in England about the middle of April, 1937, and was delivered five months later, meantime lost in the custody of the British Customs. Informing Dr. Barbour, he sent us a further consignment, which has proved invaluable when added to the first, allowing us to make a more certain examination of the genera and species. These specimens, when belonging to species of

* *Vide* pp. 173 *et seq.*

† *Cp.* Gardiner, 'Trans. Linn. Soc.' 2nd ser., xii, 257 (1908).

‡ We have not found in the Murray Collection three Malayan genera described by Alcock in the "Siboga" Report, pp. 12, 21 and 33, viz. *Lochmæotrochus*, which is a compound *Conotrochus* (Flabellidæ), *Citharocyathus*, on which we express no opinion, and *Placotrochides*, founded on two dead and decayed coralla, suggesting to us similarly decayed *Caryophyllia*. Bourne ('Trans. R. Soc.,' Suppl. Vol. 1905, p. 191) has *Rhodocyathus* and *Cyathotrochus*, each founded on a single specimen, which have obvious relationships to *Stephanocyathus* and *Trochocyathus*. All these genera, except perhaps the first, require further examination before being accepted as good; this remark also applies to *Aulocyathus* von Marenzeller ("Valdivia" Exp., p. 300, 1904) from the E. African coast, 400 and 463 m.

well-known genera, may be found referred to in our systematic section, but an examination of some genera follows; they are added to the British Museum collections.

*Schizocyathus** is represented by a cone-shaped calicle, about 3 mm. high by 2.5 mm. diameter of mouth and 1 mm. at its broken and open end, together with 6 sectors of a broken-up stem varying up to 15 mm. long. The calicle internally has 6 radial divisions, each consisting of 2 septa uniting in front of a third, which is larger, as shown in the figures; between these are spaces with tiny septa, termed "primary" and "rudimentary" by Pourtalès. With a rather thinner wall outside these divisions, it is easy to see how the long stem may split up into sectors (6), and our pieces show similarly two rows of dots corresponding to their interseptal chambers. Lindstrom supplies an admirable description of the wall of the calicle: "The epitheca of the West Indian specimens is glossy, very finely striated by minute transverse lines, which are crossed by equally fine, longitudinal striæ." Further, "there exists no wall as a separate formation, distinct from the epitheca". With this conclusion we agree, placing the genus in the Flabellidæ.

The reference of *Turbinolia* (Lam.) to the Turbinolidæ, apparently accepted by all authors, appears to us highly doubtful in view of our examination of two of Pourtalès' specimens of his *T. corbicula*,† which presumably were recently alive, but which were dead and so damaged as to cause the suggestion that they were "perhaps fossil (?)". Edwards and Haime‡ remark, "chaque sillon intercostal présente une double série des tres petites fossettes", which is made understandable by their illustrations in British 'Fossil Corals' (plates ii, iii). Pourtalès' description and figure of *corbicula* are correct, but in our opinion these "fossettes" perforate the theca and thus suggest for the genus an alliance with a different section of corals.

Thecocyathus Ed. & H.§ is defined on three fossil species as possessing "une epitheque complete". Pourtalès|| referred to it two living species, *T. cylindraceus* and *lævigatus*, specimens of which are before us. There is no reference to any theca, and we cannot find such in our specimens, although the outer parts of the septa, close under the epitheca, thicken and so become fused to one another. Alcock, of his species *cinticulatus*,¶ says that the calicle "is smothered in an epitheca so thick and copious that the edge of the calyx which just shows clear of it has a strangled and swollen look". There are no polyp tissues to protect this epitheca externally, while within there is a deposition of corallum. In specimens which one of us (J. S. G.) has examined the surface is covered with worm-tubes and borings penetrate; as the interseptal parts decay more freely the septal edges ("costæ") project. In this connection the descriptions of Alcock's *rhombocolumna* and *virgatus*** may be examined. Clearly, according to the definition of Flabellidæ the genus *Thecocyathus* should be placed in this family.

Leptocyathus as a living genus depends on Pourtalès†† and Lindstrom.‡‡ Edwards

* Pourtalès in 'Hassler Exp., Corals', 36, vi, 12, 13 (1874), and Lindstrom, 'K. Vet. Ak.' XIV, 15, with text-figs. (1877).

† 'Bull. Mus. Comp. Zool.' V, 203, i, 12, 13 (1879).

‡ 'Cor.' II, 60 (1860).

§ 'Cor.' II, 48 (1860).

|| 'Cat. Mus. Comp. Zool.' 13, ii, 14, 15, v, 3, 4 (1871).

¶ "'Investigator' Report," 17, ii, 5, 5a (1898).

** 'Siboga Exp.' 16, ii, 12, 13 (1902).

†† 'Cat. Mus. Comp. Zool.' 12, iii, 1-3 (1871).

‡‡ 'K. Sven. Ak.' XIV, 9, i, 5-9 (1877).

and Haime* in their table separate *Leptocyathus* from *Deltocyathus* by its pali existing before all cycles of septa. Three Pourtalès' specimens of his *L. stimpsoni* we should without hesitation have placed in the genus *Deltocyathus* as undoubtedly Edwards and Haime would have done, its pali agreeing. Two of the specimens have regenerated from sectors of discs, as shown in one of Pourtalès' figures, which do not show the fusion of costæ described by the author, nor that of the septa mentioned by Lindstrom.

The specimen of *Stenocyathus* Pourtalès† before us is 24 mm. long by 3 mm. across its open calicle and nearly 2.5 mm. at its broken end; it is somewhat curved. The calicle shows the characteristic central columella-rod surrounded by rods of 6 pali, and this arrangement is clearly visible at the opposite end, although the seven rods tend to fuse in the centre; the interseptal spaces are wide open. The lower half of the corallum is somewhat decayed externally. The costæ, which should show clearest immediately below the mouth of the calicle, where they should be covered by the edge-zone, are not visible here, but have become well established 3-4 mm. below. Here are transverse growth markings, such as shown in Pourtalès' figure (iii, 11). Until the relations of the polyp and corallum are determined, we cannot agree that this genus is correctly placed in the Turbinolidæ, believing its wall to be an epitheca, the costal appearance secondary, due to the decay of the epitheca, between the outer edges of the septa.‡

Specimens of *Anthemiphyllia* Pourtalès are very beautiful, especially in their well-defined theca and the thin, transparent, porcellaneous epitheca which is attached to the external ends of the septa, viz. costæ, as in *Antillia*. The septa are in two series, the larger extending to the shallow central columellar space, the smaller only clearly visible on the rim of the saucer. The broad, flattened spines on the septal edges are arranged in concentric circles around the columellar space, which is about one-third the diameter of the calicle. The columella is a rather solid, flattened mass of processes, between which there is much secondary filling in by corallum; further, there is a closing-in of the central parts by "half floors or shelves" (Pourtalès). We prefer Pourtalès' suggestions that this genus is related to *Antillia*, *Montlivaultia*, etc., and we regard it as one of the solitary Astræidæ.

A small specimen of *Guynia annulata* Duncan from the Hassler Expedition would unhesitatingly be placed by us in the Flabellidæ, the 4-system of septa being found occasionally in many genera. Surely *Pyrophyllia* Hickson§ might reasonably be regarded as a synonym of *Guynia*.

We have been lent by the Agassiz Museum what we believe to be the type and figured specimen of *Parasmilia variegata* Pourtalès.|| This species, together with *P. lymani* Pourt.,|| was placed by its author in a new genus *Dasmosmilia*,¶ with figures of new and perfect specimens from a new locality. It is stated in the original description, "dissepiments not observed, none in the upper three-fourths of the corallum", and, with the specimen before us, we see no reason to believe that they are present and to place the

* 'Cor.' II, 10 (1860).

† Vide 'Cat. Mus. Comp. Zool.' Harvard, IV, 9, i, 1 (*non* 2), iii, 11-13 (1871); 'Bull. Mus. Comp. Zool.' VI, 101, i, 15, 16 (1880).

‡ We cannot explain Pourtalès' Pl. iii, fig. 13, for we can find nothing similar. Lindstrom ('K. Sven. Ak.' XIV, 19, 1877) had not in our opinion a species of *Stenocyathus* Pourtalès.

§ 'Mem. Lit. Phil. Soc.' Manchester, LIV, No. 12 (1910).

|| 'Cat. Mus. Comp. Zool. Harvard,' XXI, 20, i, 13 (1871).

¶ 'Bull. Mus. Comp. Zool.' VI, 108, ii, 11, 12 (1880).

genus in the Astræidæ. Dissepiments are not visible in some specimens of *D. lymani* before us, likewise from the Agassiz Museum; here Pourtalès called them "rudimentary, membraniform, nearly horizontal". The specimen of *D. variegata* has ragged, inner parts of the septa, which appear to us paliform, while the columella has a number of upstanding small rods on a trabecular mass joining the septa together in the centre of the calicle. We suggest that *Dasmosmia* is a turbinolid, and that *D. variegata* may prove to be synonymous with *Tropidocyathus nascornatus* below. It certainly has the same biological characters of splitting and regeneration, but the coloration is described as different, though there is no colour in one of the two specimens before us (apparently the figured type), while traces of its supposed purple septa should persist. Two specimens of *D. lymani* have grown on sectors of coral of the same genus, but it is impossible to tell whether this is regeneration or the settlement of ova; one has two young corals growing out in its dead calicle.

IV. FLABELLIDÆ.

The corals with living species placed in this family include *Flabellum* (syn. *Rhizotrochus*, *Blastotrochus* and now *Ulocyathus*), *Placotrochus*,* *Haplophyllia* (syn. *Duncania*, *Vaughanella* and *Gardineria*), and *Conotrochus*, to which, from our examination of West Indian corals above, we suggest the additions of *Thecocyathus*, *Stenocyathus*, *Schizocyathus* and *Guynia* (syn. *Pyrophyllia*).† The critical character, separating the family from Turbinolidæ, is that the polyp has no edge-zone, hence does not extend outside the calicular wall, which is accordingly formed by an epitheca.‡

Employing this definition, *Conotrochus* belongs to this family, for its only wall is epithecal. After a coral has defined itself in its growth and reached maturity, when growth in size slows down as in all animals, an additional deposition of corallum may take place underneath the polyp tissues, where the skeleton is formed, viz. under the calicoblastic ectoderm, but may be specialized to certain parts. This is clearly seen within the external epitheca in many species of *Flabellum* and is especially the case in *Conotrochus*. We suggest that it is mainly a physiological character, concerned primarily with the rate of metabolism and is not comparable to that filling-up and strengthening of the whole corallum in its interseptal spaces by dissepiments and otherwise, so characteristic of the Astræidæ.

Genus *Flabellum*.

The genus *Ulocyathus* M. Sars§ is described at great length. "La surface extérieure du calice et la base sont nues sans aucune membrane couvrante" shows that this genus must be regarded as synonym of *Flabellum* (Lesson)—a conclusion amply supported by the whole description in spite of a reference to outer ridges, which are termed "costæ".

* *Vide* Bourne, 'Trans. Roy. Soc.,' Suppl. Vol., 1905, 200, i, 5. See also his definitions of the families, pp. 189 and 195.

† *Vide* p. 172.

‡ The astræid, *Antillia*, has both epithecal and thecal walls, but there are no Flabellidæ showing these characters.

§ 'Fauna Litt. Norvegicæ,' XI, 73-9, x, 18-27 (1856).

Flabellum pavoninum (Lesson).

For literature and synonymy see Gardiner, 'Marine Invest. in S. Africa', II, 123 (1902), and 'Records Indian Mus.' XXXI, 301 (1929).*

St. 89, 193 m., s. sh. r., 1 dead.

St. 104, 207 m., gr. gy. s. m. sh., 1 dead.

St. 106, 183-94 m., gn. m., 6 living and 28 dead.

St. 123, 256-366 m., gn. m. s. r., 1 living and 1 dead.

St. 149, 238 m., cr. r. lth., 1 dead.

St. 157, 229 m., cr. r., 1 living and 3 dead.

An examination of one polyp assured us that this is the South African species. Evidently a widely distributed species of moderately shallow waters, with *F. rubrum*.

Flabellum rubrum (Q. et G.).

For literature and synonymy see the same references as under *F. pavoninum*. The species was similarly checked by a polyp.

St. 45, 38 m., lith., 1 living.

St. 89, 193 m., s. sh. r., 2 dead.

St. 106, 183-94 m., gn. m., 3 living, 7 dead.

St. 149, 238 m., cr. r. lith., 2 dead.

St. 209, 366 m., gr. br. m. r., 7 dead.

Some of these specimens might be referred to *F. stokesi* Ed. & H., which we do not regard as a gametic species or variety of *F. rubrum*.

Flabellum (Rhizotrochus) crateriformis Alcock.

Journ. Asiatic Soc. Bengal, LXII, 2, viii, 1, 2 (1893).

St. 209, 366 m., gr. br. m. r., 1 living (32 mm. greatest height, calicular opening 28×23 mm.), 6 dead (largest straight, 38 mm. high with calicular opening 38×35 mm.). (Alcock's specimen was from Bay of Bengal, 573 fms.)

This is a good description, but of course the pedicular scar is not a specific character, while the shape varies greatly. The calicular orifice varies from almost circular to flattened, with breadth to length as 3 to 5. The shape may be upright and is usually cornute, often bent. The rootlets are only found on the lower half and may be merely blunt projections on the corallum, but clearly in the young have a real function for support. One dead specimen is a conical corallum on the septa of which a second polyp has settled; here there are confluent rootlets forming a large base extending over many septa. These

* We have found it most inconvenient in our systematic studies to place our references in a "List of Literature", an appendix. For corals we require (1) name of publication, (2) volume of same (roman), (3) the page (arabic), (4) if figured the plate (roman) and the figures (arabic), (5) the date of publication, and these are given in each reference. Often there is no volume number, merely date, which then is given in the place of (2) above.

It may be added that throughout this Report descriptions have been greatly reduced where photographic figures are given, these being regarded as of peculiar importance for purposes of identification.

rootlets of *Flabellum* must grow by the polyp edges overflowing or growing out over the rim of its corallum, which is subsequently built up higher, for there are no signs in any specimens of this or other species that we have examined of the epitheca being perforated. The position for a rootlet here is normally over one of the larger 24 septa, which is continued down the rootlet for some distance.

Genus *Conotrochus* Seguenza.

Conotrochus Seguenza, Mem. R. Ac. Sci., Torino, ser. ii, 477 (1864).

Pleurocyathus Moseley, "Challenger" Reports, 159, ii, 1 (1881).

Ceratotrochus (*Conotrochus* et *Phlæocyathus*) Alcock, "Siboga" Exp. 12, ii, 8 (1902).

This genus clearly belongs to the Flabellidæ and is separated from *Ceratotrochus* by its single wall being epithecal and its columella being fasciculate, its rods perhaps twisted; these points are made clear by Seguenza. That the epitheca is depressed as it passes over the outer edges of the septa allows an illegitimate reference to costæ, which do not exist. It would seem probable that Seguenza's work was unknown to Moseley.

Conotrochus brunneus (Moseley). (Pl. V, figs. 11 and 12.)

Pleurocyathus brunneus Moseley, "Challenger" Reports, 159, ii, 1 (1881).

Ceratotrochus (*Conotrochus*) *funicolumna* Alcock, "Siboga" Exp. ii, 1, 6 (1902).

Ceratotrochus (*Phlæocyathus*) *hospes* Alcock, "Siboga" Exp. 12, ii, 8 (1902).

St. 145, 510 m., gn. m. s., 10 living and 2 dead.

The following description is founded on 10 specimens all living when obtained, the previously known forms consisting of 1 living and 3 dead coralla. An examination of these with Seguenza's *C. typus* may show that the living and fossil forms are inseparable.

Corallum attached, generally becoming free, conical; calicular opening rounded or very slightly oval. Whole covered by epitheca, raised over edges of the septa into ridges (not costæ), usually with numerous circular "growth" markings, whole wall relatively thick, the epitheca strengthened by internal deposition of corallum.

Septa: upper edges slightly below an upstanding rim of epitheca, broad at their upper edges, sloping nearly perpendicularly to the marked central columellar area, edges usually smooth, but growth of septa is by longitudinal ridges and each of these may end in a small tooth; surfaces granulated; four cycles, I to III larger, joined to the columellar mass, and alternating with them those of IV smaller, not so connected and extending much less deep into the corallum.

Columella always distinct, twisted rods usually strengthened in places by horizontal trabecular junctions, the whole forming a rounded or slightly oval upstanding mass.

Highest 18 mm., average 14 mm., diameter calicle 9–13 mm.

The young polyp attaches itself to any solid object, in three specimens a bivalve shell, a piece of gorgonian and an irregular fragment of some mollusc. When possible its base broadens out to 2 or 3 mm. before the cone grows up. Then it usually becomes free, breaking off the decaying object to which it is attached. It often bends at an angle, so that its attachment seems to have been sideways, the corallum remaining straight. When it becomes free there is a tendency for the base to become somewhat pointed. The external "growth" markings we suppose to represent periods of food stimulation.

The upper edges of the septa are usually about .5 mm. below the edge of the epitheca and, while in deep specimens they remain thus, in shallow forms may be visible above the epitheca as in Alcock's *funicolumna*. There is considerable variation in the granulation of the septal sides and edges, but the granules are always small, perhaps in the largest specimens smallest. The depth and size of the columella is a growth variation, the range being from 1 to 5 mm. in depth and from one-sixth to nearly one-third the diameter of the calicle; its surface is always clearly upstanding above the septal junctions to itself. In one specimen the columella looks to be formed of two irregular rods, but these consist respectively of 5 and 4 rods fused by subsequent deposition of corallum. In another it has about 20 rods all separate on the surface. In all cases the rods are twisted and irregularly interlocking, so that a very distinct columella-mass results.

The three "species" are clearly one, since they fall within the range of our suite. *C. hospes* is founded on a specimen apparently grown slowly in unfavourable conditions, the corallum thickened within its calicle by deposition as may be seen in most reef colonies of astræids, especially where they grow out and shade their sides.

V. TURBINOLIDÆ.

Genus *Desmophyllum* (Ehr.).

Two small young living specimens, St. 111, ? r., g 73-165 m., and 153, 256-293 m., both indeterminate.

A third, in spirit St. 185, 2000 m., gn. m., may be placed here, but it is a very young form with its septa joined in the centre.

Genus *Caryophyllia* Lam.

Caryophyllia clavus Scacchi. (Pl. I, fig. 1.)

Cyathina pseudoturbinolia Ed. & H., Ann. Sc. Nat. 3^e ser., IX, 289, ix, 1 (1848).

Caryophyllia clavus Ed. & H., Hist. Cor. 15 (1857); Duncan, Trans. Zool. Soc. VIII, 311, xlviii (1873);

Lacaze-Duthiers, Arch. Zool. Exp. Gen. 3^e ser., V, 37, i, ii (1897); Marenzeller, pars, "Valdivia" Exp. XVII, 281, xvi, 9 (1904).

C. communis Moseley, pars, "Challenger" Reports, 135, i, 4, 5 (1881).

St. 119, 1207-1463 m., 27 specimens dried off. The average size of calicle is 27×22 mm., and the average number of pali 16. The maximum sizes are 32×29 mm. and 32×30 mm., 17 and 16 pali; two (23×20 mm.) have 14 pali each and two (29×24 mm. and 27×22 mm.) have 18 pali each.

St. 122, 732 m., gy. gr. m., 2 living and 4 dead; largest 25×20 mm. and 20×16 mm., 14 and 15 pali; low growing forms.

St. 143, 797 m., gr. s., 1 living, 20×15 mm., 14 pali.

St. 144, 31 m., c. sh. s., 1 living, 25×16 mm., 14 pali, very exsert septa and rather massive growth; anchorage outside Fadifolu Atoll, Maldives.

St. 185, 2000 m., gn. m., 86 living, 52 specimens have the calicle varying in length from 20 to 29 mm. and breadth 18 to 27 mm., the average difference about 4 mm., but in one case 9 mm. longer. Of these 33 have 16 pali, the number varying between 14 and 19. A partially regenerated form (20×20 mm.) has 20. 22 coralla of calicular length 10 to 19 mm. vary from 10 to 14 pali, and one form, 6×5 mm., has 27 septa and 6 pali.

This species has been sufficiently described, with the photograph now added (Pl. I, fig. 1), and the variation in its main characters is shown above. All forms are cornute, and with growth and increase of weight appear to become free, tumbling to one side. The polyp seldom extends more than 5 mm. down outside the corallum, which shows low costal ridges covered by an epitheca, which has a tendency to be completely dissolved away. There is relatively little variation in thickness of septa and pali, but the former vary in exsertness. The columella is usually markedly below the palial level and consists of a small number of relatively broad, twisted ribands; it may fill up the central space as an elongated area or be almost round, when the calicle is rounded. Several of the specimens have parts of their coralla broken and regenerated (central corallum on Pl. I, fig. 1).

Caryophyllia grandis n. sp. (Pl. I, fig. 2.)

St. 145E, 494 m., 71 specimens.

Corallum dark coloured, mauve purple; cornute and markedly compressed; attached by a fine peduncle when young, generally free later and bent as in *clavus*; polyp extending down outside for 5 mm.; lower part covered by epitheca, which is often dissolved away. Costal ridges variable, but always low.

Twenty-four septa (I, II and III) broader, thicker and markedly more exsert, rather spiny on sides and often showing growth-lines, not visibly connected to columella, but joined by trabeculae below. Then 24 septa (IV) much narrower and lower, with 24 pali plate-like, varying up to 4 mm. long, and spiny sided. Lastly 2 smaller and thinner septa (V) on either side of IV and quite distinct.

Columella twisted and relatively coarse ribands, generally forming a rather solid mass well below palial level; in a narrow calicle about one-third its length by 2-3 mm. broad, but with increase in breadth becoming more oval.

Measurements: Of 57 apparently adult forms (calicle at least 20 mm. long) 9 are 30 to 34 mm. long. The length of calicle to breadth is as 1.1 to 1.5 : 1, the average being 26.2 by 20.8 mm. The larger forms usually have 24 pali, the average being 21.8.

The species is characterized by its shape and its large number of pali. One corallum (9 × 8 mm. calicular length) has 12 pali and there are 14 intermediate-sized forms (10 to 19 mm.) with pali varying from this to 20.

The species differs from *C. clavus* in a certain appearance of density, due to the maximum number of septa in this species being $8 + 8 + 16 + 32 = 64$ as compared with $6 + 6 + 12 + 24 + 48 = 96$ here, but undue emphasis should not be laid on the cyclical arrangement. The septa also are thinner, finer, less spiny and less markedly exsert. Odd specimens of *clavus* and *communis* referred to by Moseley, Duncan and Marenzeller may well belong to this species.

Caryophyllia scobinosa (Alcock). (Pl. III, fig. 7.)

"Siboga" Expedition, 8, I, 2 (1902).

St. 108, 786 m., gy. m., 172 living and a large number of dead specimens.

St. 125, 805 m., lt. br. m. over gl. cl., 1 living.

Corallum cornute, rather flattened, varying in height but never tall, all bent and free; most with tiny scar of former attachment.

Externally two zones, that near the calicle seldom more than a quarter the height, covered by polyp tissue and translucent, and the remaining three-quarters opaque with surface worn. Costæ in consequence made more conspicuous below but subequal, those of cycles I and II slightly more prominent.

Septa I and II very markedly exsert, septa IV against same much more exsert than III. All septa relatively thin and granular; no conspicuous growth-lines on sides. Septa I and II sloping perpendicularly, but deep down connected to the columella. Septa III with very conspicuous broad flattened pali, remarkably upstanding, their central line opposite the inner edges of septa I and II. Septa IV same breadth as septa III outside the palial region.

Columella as a rule deeply placed below the upstanding pali, rather flattened and narrow, generally consisting of 3-4 flattened riband-like, twisted processes.

Size of calicular opening 15×11 , 12×10 , 11×10 , 12×11 , 13×12 , 10×9 mm., etc.

These specimens are inseparable from Alcock's species (6 specimens from 535 and 794 m.), the large majority the size of his smaller forms. There are three large specimens, calicular openings 19×15 , 21×14 and 19×14 mm., the highest not more than 15 mm., and hence with remarkably open calicles. All these three have 14 pali, while in the bulk of specimens 12 is the regular number.

Caryophyllia mabahithi n. sp. (Pl. III, fig. 6; Text-fig. 1.)

St. 34, 1022 m., gn. m., 29 living, 31 recently dead.

St. 143, 797 m., gr. s., 1 recently dead, 10 mm. high and calicle 10×9 mm., with two additional septa.

St. 176, 655-732 m., gn. m. s., 3 recently dead.



FIG. 1.—*Caryophyllia mabahithi* n. sp. $\times 5$.

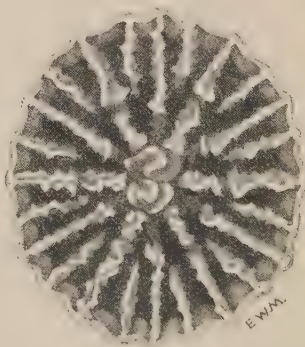


FIG. 2.—*Caryophyllia cornuiformis* (Pourtales). Side view $\times 3.5$, and mouth $\times 9.5$.



Corallum horn-shaped and bent to one side, unusually low and broad, slightly compressed; free, with flat scar of former attachment. Often with transverse growth markings externally. Costæ of all septa low ridges.

Septal cycles in eights; septa I rising markedly higher than the thecal wall; septa II much lower, with flattened pali in front of same; septa III narrower and less massive

than last, complete in number. All septa with longitudinal growth-lines and these studded with low spines or granules, giving a rough appearance.

Columella relatively shallow, consisting of 1 to 4 rather coarse twisted ribands.

Measurements: about 13 mm. high (measured vertically, not round the bent horn); calicular opening 12×10 , 12 and 10×8 , 11 and 10×9 , 9 and 10×9 , 10 and 11×10 , 9 and 8×7 mm., etc.

The number of pali, viz. 8, which is a very constant character, allies the species to *C. octopali* Vaughan,* of which there were three specimens from Hawaii, 281–371 fms. It differs in its more definite cornute shape and its very narrow base; its septa III are always much narrower than II. Septa I are often markedly exsert, but there is great variation in the range here, while II and III are much lower and nearly similar. The twisting of the columella-ribands on one another is most noticeable, and in rounded calicles gives a rather solid appearance.

Caryophyllia cornuformis (Pourtalès). (Text-fig. 2.)

Cat. Mus. Comp. Zool. I, 9, i, 14–15 (1871); amended Bull. Mus. Comp. Zool. V, 188 (1878).

C. vermiformis et *pourtalesi* Duncan, Trans. Zool. Soc. VIII, 316, xl, 13–16, xlii, 3–10 (1871).

C. carpenteri et *simplex*, Duncan, Trans. Zool. Soc. X, 237, xliii, 28–34 (1878).

St. 103, 101 m., c. s. sh., 2.

St. 105B, 238 m., gn. m., 32 specimens mostly living, their pointed ends bedded in small, hemispherical Polyzoa.

St. 112, 113 m., cr. r., 1 living.

St. 178, 91 m., c. gn. s., 2 living, 2 dead.

The above four species have three cycles of septa, but Portalès' original description is scanty and his figure bad; I have, however, two of his specimens before me, both relatively large and old forms. Duncan has confused Portalès' description of *pourtalesi*. For the rest he founded three species on three specimens from 539 and 740 fms. in the Atlantic. They are all figured, presumably correctly; not one can be regarded as a healthily grown specimen, and the last two are obviously worn down externally. Here is the description of our suite of nineteen specimens:

Corallum cone-shape, free or with tiny base of attachment, generally with transverse, ridged growth-markings.

External surface with finely granular costæ, those belonging to septa I and II sometimes a little more prominent, all rather broad and rounded.

Calicular opening almost round. Septa very slightly exsert; I broader and falling perpendicularly to centre; II less broad, with 6 flattened pali in front of same; III thinner and extending about a third of the way to the centre; all with longitudinal growth-lines, looking as if covered with low spines when the calicle is looked into.

Columella 1 to 3 twisted riband-like processes, the depth of its surface depending on the growth of the whole corallum.

Height varies up to 15 mm., diameter of calicle to 7 mm.

* 'U.S. Nat. Mus.,' Bull. 59, 74, v, 2 (1907).

Caryophyllia compressa n. sp. (Pl. II, fig. 4.)

St. 105B, 238–293 m., gn. m., 41 specimens, about half dead.

Corallum with a fine-pointed attachment or more usually free, gradually expanding to the calicular opening, which is about twice as long as broad. Sometimes transverse growth-lines externally.

Costæ well marked, those of cycles I and II more outstanding, the two primary at the ends of the calicle higher and often forming distinct wings, all of about equal thickness and finely granulated.

Septa I and II about 3 mm. exsert, while septa IV against the same about 2 mm. and III 3 mm. lower, all measurements above thecal edge. Septal sides with longitudinal growth-lines often shown in granules; septal edges untoothed. Septa I and II markedly broader, dropping perpendicularly to level of columella about 6 mm. below, then joined to same by trabeculæ. Septa III and IV equal, but III joined up to flattened pali, which are often spiny, and so to the columella.

Columella a line of twisted ribands deep down the centre of the calicle about 5 mm. below the top ends of the highest septa, always conspicuous.

Height varying to 25 mm.; calicular openings such as 20×11 , 17×9 , 17×8 , 25×12 mm.

About 10 specimens are in good condition. The wings formed by the terminal costæ variable, but usually well marked and up to 3 mm. broad. While some specimens would seem to have been almost entirely covered by polyp tissues, in others the extrathecal portions of the polyps have been killed, so that the polyps form mere caps. In two specimens this has gone so far that new polyps have grown out in the old cups. Where the calicular opening elongates, an extra pair of septa of cycle III may appear, with corresponding additional pairs of septa of cycle IV, but 12 thin conspicuous pali is a regular feature.

With these specimens were 7 young forms, mostly much broken. One specimen 6 mm. high 8×4 mm., calicle has 12 septa of I and II and the commencement of cycle III without pali as yet and none of IV.

As to previously described species *C. clavus* var. *transversalis* Moseley ("Challenger" Report, 134) is not nearly so flattened and has no trace of wing costæ. It is difficult to compare with *Acanthocyathus grayi* Ed. & H.,* a single specimen of which of unknown origin is represented with 16 pali—a character shared by its fossil companion *A. hastingsii*.

Caryophyllia sewelli n. sp. (Pl. II, fig. 3.)

St. 209, 366 m., gn. br. m. r., 3 living and 30 dead coralla.

Corallum elongated, cornute, expanding gradually to the calicular end; evenly costulate externally, finely granular, broad lines.

Septa I and II markedly more exsert than rest, thecal wall rising higher on sides of same and including the neighbouring septa (IV). Septal sides varying from almost smooth to longitudinal ridges, perhaps with lines of spines parallel to the septal edges. Septa III and IV much narrower.

Pali crown very marked, 12 broad flattened rods with spiny sides, sometimes an extra pair in compressed coralla.

* 'Ann. Sci. nat.' 3^e ser., IX, 293, ix, 2 (1848).

Columella generally 2 to 4 rods arranged in a line, their ends markedly lower than the tops of the pali, sometimes in a group less regularly arranged.

Measurements: height up to 40 mm.; calicle up to 20 mm. across by 15–18 mm.

Evidently there had been a great mass of these corals growing together attached to sides of each other, as described by Alcock in *C. paradoxus** and Moseley in *C. profunda*,† from which they are separated in the great regularity of their septa and pali, which only in 5 specimens show an extra pair. A number of dead pieces were cut or broken, but in no case was any communication found between the cavities of the calicles; this does not preclude the possibility of the arrangement being due to extrathecal budding, but this seems unlikely. In 1 living and 5 dead specimens the polyp has been partially killed externally and new calicles have grown out in the centres of their predecessors. In the living corals the outer parts of the septa are purple coloured.

The dead coralla show the costæ levelled down and smoothed. The exsert portions of septa I and II are commonly removed. The septa are all thickened, a characteristic more marked in the pali which appear more massive than in the living corallum of any described species. This, too, is seen in the columella rods, which this external deposition of lime has often fused together.

Caryophyllia paradoxus Alcock.

“Investigator” Report, 14, i, 2 (1898).

St. 209, 366 m., gr. br. m. r., 1 living, broken off its base of attachment.

A simple corallum with pali rather like “little ragged lobules of the septa” and columella “a good-sized mass, consisting of loosely-connected, irregularly-twisted, often ragged and granular, processes”. Evidently a most variable species.

Genus *Paracyathus* Ed. & H.

Ann. Sci. nat. 3^e ser., IX, 318 (1848); Cor. II, 52 (1860).

Polycyathus et *Agecyathus* Duncan, Proc. Zool. Soc. 1876, 433.

The genus presents little difficulty of determination. As to species we found about 30 described species, based apparently on less than 40 specimens in all, besides a few founded on proper suites. Size, regularity in height of septa, nature of pali and of columella are their chief characters, the greatest stress laid on the last two; some coralla were obviously distorted and others immature. Selecting specimens out of the collection before us and destroying the rest, we could easily add a dozen equally good “species”. We thus must decline to recognize few, if any, of such “known” species, as there is no uniformity in any of the above characters in any of the present series, except in size.

In contrast we have a careful study by Lacaze Duthiers‡ of specimens from the Gulf of Lions, which he assigns to *P. striatus* and *P. pulchellus*, both being species placed by Edwards and Haime§ in their division “a palis entiers”. They differ from our species below in not having the septa of I and II so markedly large, but more especially in having a columella of 15 to 25 rods.

* “Investigator” Report, 14 (1898).

† “Challenger” Report, 138 (1881).

‡ Arch. Zool. Exp. Gen. 3^e ser., V, 120–31, vi, vii (1897).

§ ‘Cor.’ II, 55 (1860).

There are also many coralla from the West Indies supposed to belong to *P. de filippii* D. & M.,* but neither the description nor the figures of these authors show the specific characters of our species below (*gardineri*). Vaughan† identifies *P. confertus* Pourtalès,‡ the original accounts of which are scanty, with *de filippii*. Neither Vaughan's nor Pourtalès' figures add much to earlier accounts, nor do they indicate agreement; hence a redescription of the numerous American specimens is required.

From the Indo-Pacific, eliminating all founded on single specimens, *P. parvulus* Gardiner|| (11 specimens), *P. lifuensis* Gardiner§ (2) and *P. fulvus*|| (3) are separated *inter alia* by the nature of the columella. *P. gardineri* Vaughan¶ is described in terms applicable to one of our species, his fig. 4a identical with several specimens. As we have a long series, we append a fresh description, founded on our suite of coralla, and hence indicative of the variation of the species.

In the species *P. conceptus* below, a regular method of reproduction is by outgrowths of polyps from the extrathecal part of the polyp. The latter is a cap of two layers of tissues, with the coelenteric cavity between, seated on the top of a coral cup to which its lower part fits closely over all its structures, which, indeed, it is building up. The lower surface here is covered by somewhat flattened calicoblastic ectoderm and the free surface above by a columnar epithelium. It is apparently where these two qualities of ectoderm meet, just above the epithecal formation on the stem, that "budding usually" takes place. The new corallite is deposited upon its parent's column, but later on its polyp, as the parent corallum grows higher, severs its connection with its parent.

It frequently happens with coral polyps that one may be killed over some part of its surface, when the still living part will grow out and regenerate the whole. This frequently takes place at the position described above, where the naked epithecal surface below becomes overgrown by worm, barnacle or other organisms which fight to grow along the coral stem at the expense of the polyp; in nearly all cases cause and effect are apparent, and we conceive this to be the cause of the formation of the buds in *P. conceptus*. They do not produce a "colony" comparable to that of the "colonial" corals in that all the daughter-polyps quickly become independent of parents and of one another. This may be a sufficient difference to be deemed a generic character, but we require to ask ourselves whether the Linnean terminology is intended merely for cataloguing, or to indicate real relationships. In the case before us the corallites present all the characters typical of *Paracyathus*, and because they are prolific parents, in an asexual manner, we see no reason to adopt for them a surname which hides their descent.

The above remarks apply to the whole genus *Polycyathus*, but the descriptions of its recorded species are founded on an insufficiency of specimens to determine the species of sedentary animals, while they were based on incorrect ideas of structure and formation

* Duchassaing et Michellotti, 'Mem. Cor. Antilles, Turin,' 60 (1860). A clump of specimens ("off Barbadoes") before us are of small size, largest calicle 7 by 6 mm., and were almost entirely covered by polyp tissues. A specimen, collected and termed *confertus* (Florida, 97 fms.) by Pourtalès is almost certainly within the range of *de filippii*.

† 'Bull. U.S. Fish. Comm.' 2, 292, I, 1, 1a (1901).

‡ 'Cat. Mus. Comp. Zool.' 11, vi, 11-13 (1871).

§ 'Willey's Zoological Results,' 165, xix, 4 (1899).

|| 'Journ. Asiatic Soc. Bengal,' LXII, 139, v, 2 (1893).

¶ 'U.S. Nat. Mus.,' Bull. 59, 68, iv, 4a, b, 3 specimens (1907).

of corallum. Thus Duncan* gives us the above genus and also *Agelecyathus*, which is assuredly the same genus. Three species of these genera were described by him on three specimens, all seemingly young forms. The largest is *atlanticus*, calicle 7 mm. broad, and there is so remarkable a dissimilarity between the descriptions of its pali and columella and the figure of its enlarged calicle that we dare hazard no guess as to its relationships. Pending re-examination of these types of genera and species, we consider that they must disappear from our literature.†

Paracyathus gardineri Vaughan. (Pl. III, fig. 5.)

U.S. Nat. Mus., Bull. 59, 68, iv, 4a, b (1907).

St. 43, 83–100 m., 1 living, small, overgrown by organisms; doubtful.

St. 106, 183–194 m., gn. m., 1 dead.

St. 149, 238 m., cr. r. lth., 5 dead.

St. 157, 229 m., cr. r., 170 dried off and many in spirit, over 90% living when obtained.

Corallum fixed by a broadened base of attachment, above this a narrower stem rising with constantly increasing diameter. All specimens detached, a few secondarily pointed at the base, some broken, showing a heavy, secondarily thickened wall; all much overgrown by organisms, most to within 2 or 3 mm. of the edge of the calicle.

Costæ largely obliterated by epithecal deposition below, closely and evenly packed, relatively thick and equal in size; in thicker, more exsert portions granules almost regular in lines across the edges of the costæ.

Calicle: opening varying from round to oval, but length by breadth seldom beyond 4 by 3, most elongated, general appearance dense. Terminal septa cycle I, 2 septa of same on either side, all markedly more exsert, massive and broader, and the narrower and less exsert septa of cycle II intermediate; septal cycles III and IV complete, thinner, narrower and less exsert. All septa untoothed with longitudinal growth-ridges on sides, these with low spines, their appearance granular when looking into the calicle, all closely set and gradually thickening where the theca joins them.

Central area of calicle variable, generally 2 to 3 mm. below the exsert ends of the broader septa, the whole more or less flattened, palial and columellar area here about one-third the diameter of the calicle.

Pali or paliform lobes: before all septa of cycles I to III, thick, rounded, flattened, or angular rods before I to narrow upstanding plates; compressed plates progressively thinner before II and III, but all varying greatly in thickness. Pali generally single, but many bilobed, if the filling of space so demands, this doubling sometimes markedly visible off the inner edges of terminal septa of I; where the sides of the calicle slope towards the centre, often chevron-appearance, but no fusions visible from above.

Columella: general character usually 3 or 4 rods, relatively large, in a line between the primary septa at the ends of the compressed calicle; the 12 central pali and this regular line of columellar rods usually filling in the central space, additional rods only appearing occasionally where gaps occur.

* 'Proc. Zool. Soc.' 1876, 433, xxxviii, 14–16, xxxix, 1–6.

† While here there is no question of any connection between the cavities within the thecal parts of two attached coralla, there is said to be such communication in *Cænocyathus* Ed. & H. and *Gemmulatirochus* Duncan. Vide Duncan, 'Journ. Linn. Soc.' XVIII, 33 (1884); also Doderlein, 'Mitt. Zool. Sta. Neapel,' XXI, 118 *et seq.* (1913).

Size varying up to 3 cm. high; length of calicle up to 17 mm. and breadth equal to two-thirds of length, the averages about 14 mm. by 10 mm.

The chief characters of this species as apart from size and compression lie in the markedly exsert, conspicuous and broader septa I and II, in the regularity of the pali seldom bilobed, and in the columella primarily consisting of a line of conspicuous rods down the central valley. But with each character, especially the last, there is variation induced by growth-shape, this presumably correlated with an environment of Foraminifera, worms, barnacles, Polyzoa and other sedentary organisms overgrowing the columns of the corallites. Prominent growth-lines show alternately on either side of the septa. In sections centres of calcification or deposition of corallum are visible, and this deposition is more extensive alternately on opposite sides of the septa, the edges of which, when viewed from above, may have a zigzag appearance. So far as we can judge, the dark "centres of calcification" consist of grains of limestone arranged irregularly in respect to one another, whereas crystals of aragonite in further thickening fit on to one another, facet to facet.*

All the specimens appear to be adult. None show any budding, nor are there any young attached coralla on their sides, such as might have been expected.

Paracyathus conceptus n. sp. (Pl. IV, figs. 8 and 9.)

St. 157, 229 m., cr. r., over 200 specimens.

St. 208, 732-805 m., gr. br. m. r., 12 living and 2 dead.

Coral with broad base of attachment, upon this a cone-shaped corallum growing up, often bent; secondary coralla budded off the sides of same, where the polyp tissues cover the coral outside, the result a low bush with 2 to 6 or more upstanding calicles. Basal part of the whole covered by a thick deposition of epithecal corallum, to which sedentary organisms freely attached themselves, the separate corallite-polyps becoming physiologically separated. Stems of corallites usually or nearly solid below, epitheca and theca broadened and interior largely filled up; no communications between central cavities of corallites.

Calicle overlapped outside by the edge-zone of the polyp, usually for about 5 mm. In this part costæ (the peripheral parts of all visible septa) rather thick, subequal in size, granular edges. Calicular opening round to oval, sometimes highly compressed, with sides much higher than ends, the theca at the ends of the valley much lower than at the sides.

Septa all exsert, I and II broader, thicker and slightly more exsert, up to 2 mm. Edge of theca formed by the junction of all the septa, quite regular in height between the septal tops. All septa with longitudinal growth-lines, which show even in their costal parts, edges entire, whole looking granular from surface view of calicle. Septa I to IV

* *Vide* Dr. Ogilvie, 'Trans. Roy. Soc.' 187, 83-345 (1896). This character of "centres of calcification" initiating the growth of septa is common to all the Turbinolidæ. In sections they are situated at some distance from one another. Corallum is deposited all round them. In the line of the septum it meets, but on its faces it may show raised ridges extending down the septa, commonly termed lines of growth. These often are set with low, pointed spines which may give a rough appearance when looking into the calicle.

fairly distinct and graded in size, very close set, regular and relatively thick, the last cycle in any system absent if space does not allow, while, if growth gives room, some septa of V present.

Pali : rods before septa I, a little flattened before II ; flat plates before III, generally divided into 2 or 3 lobes.

Columella : central space open, closed in by a number of small upstanding rods, their surface below that of the pali ; number variable, but in average coralla 20 or more, all joined below by trabecular junctions extending from the larger septa ; between the septa open interseptal spaces.

Measurements : maximal size of bush about 5 cm. high by same in diameter, usually much lower ; of calices, if round, about 15 by 13 mm. grading to compressed forms 21 mm. long by 8 mm. and upwards in breadth ; top of columella situated up to 5 mm. below exsert ends of septa.

These corals from St. 157 were obtained by a 4-ft. triangular dredge and appear to have been torn off a firm, level substratum by its sword. About half are intact, suggesting that the substratum was not as hard as the corallum, which at the base of the corals is almost solid ; some specimens suggest that the material, of which the bottom is composed, is coarse sand formed of organic remains which have become solidified. All were covered with epizoids, amongst which were observed barnacles, bivalves, brachiopods, foraminifera, sponges, *Spirorbis* and polyzoids, there was much growth of branching gorgonians.

The young coral usually gives off its first daughter-corallite while its stem is less than 10 mm. high, all this basal part subsequently filled up externally by a thick deposition of epithecal corallum. Generally there are no more than 3 to 6 of these basal coralla, which may become almost equal in size, any further formations of daughter-coralla at a higher level being frequently seen to be correlated with unfavourable conditions, and perhaps death of single coralla. In one dead specimen there is apparently an almost perfect example of "fission", but another specimen, in which the polyp has been killed at one end and in which the septa have grown up to form a fresh theca, shows this to be a quite false idea ; another small corallum suggests that fusion is not impossible.

The growth changes in the coralla are very regular. The youngest bud about 1 mm. in diameter has 12 septa in two cycles, with the centre of the calicle open. At 2 mm. most septa of cycle III are visible, and septa of I join together in a mass of twisted trabeculae in the central space. At 3 mm. there are upstanding rods upon this and some pali have appeared, while at 4 mm. the genus is quite clearly *Paracyathus* ; at 5 mm. the regular arrangement of pali and columella is clear. So far growth has been rapid, the corallite 10 mm. or more high, its stem clean, with no foreign growths on same. From this stage there is next an opening out of the calicular mouth, which attains an average diameter of 11 to 14 mm., but the proportionate sizes change but little, the stems thickening by epithecal deposition. The collection suggests that now there is a great slowing down in the growth-rate of the calices, and many corallites are found to be dead ; at the same time there appears to be a heavy deposition of corallum internally, giving almost complete solidity to the corallites in their lower parts.

Lastly, we would remark that although there are large numbers of *P. gardineri* and this species from St. 157, there is not a single example which suggests any method of budding in the former, nor is there even one which cannot be easily separated specifically by the characters of its columella.

Paracyathus stokesi Ed. & H.

Ed. & H., Ann. Sci. nat. 3^e ser., IX, 319, x, 7 (1848); Cor., 52 (1860).

Paracyathus agassizii Duncan, Trans. Zool. Soc. VIII, 319, xliii, 5-8 (1873).

St. 45, 38 m., lith., 2 living, attached to calcareous sponges.

St. 177, 274-366 m., gn. m. r., 1 living.

There are two excellent descriptions with figures of this species, showing the very characteristic central area of the calicle, depressed in the centre and crowded with columellar rods merging into a paliform area, the latter with pali on the lines of the septa. There is nothing like this in *P. striatus* and *pulchellus* as described by Lacaze Duthiers.*

The largest specimen (St. 45) has been broken off its base, where it is about 10 by 12 mm. in diameter, the coral wall here very thick and overgrown by calcareous algæ. The calicular opening is 21 by 11 mm., the central part 6 mm. deep. There are 100 septa; these are little exsert, tightly packed with very spiny sides. They fall almost perpendicularly inwards for half the radius; their outer parts are untoothed, but all septa except the last cycle have paliform teeth, generally before I and II much flattened, perhaps divided into 2 or 3, the others with a series of teeth (up to 8) merging centrally into about 100 fine rods which form the columella. All this central part is stained black-purple, which shows also in the broken base.

The other specimen from St. 45 has calicle 15 by 9 mm. and is 12 mm. high; it is attached by a broad base, and the last cycle of septa is less developed; the whole cup, theca and costæ included, is similarly coloured. Its base is white and is attached to a polyzoon branch, covering upwards of 90 sq. mm. From this a cone arises, 15 mm. high, with a round calicle 9 mm. across, this part dark purple. From within this calicle a new cup was growing up, now 6 mm. in diameter, as seen by a new thecal formation; its septa clearly continuous with those of its parent.

In addition to the above species two specimens from St. 89, 193 m., s. sh. r., and St. 112, 113 m., cr. r., suggest *P. porphyreus* Alcock.† Four further coralla from St. 72, 73 m., c. s. sh., may be related to *P. (Polycyathus) andamanensis* Alcock,† but it is not always easy to determine odd specimens. One calicle appears to have been dividing into two; there is no trace of any colouration.

Genus *Heterocyathus* Ed. & H.*Heterocyathus æquicostatus* (Ed. & H.).

Gardiner, Marine Inv. S. Africa, III, 104-14, 125, iii, 1904.

Harrison and Poole, Proc. Zool. Soc., 1909, 913.

Harrison, Proc. Zool. Soc., 1911, 1021-26.

Bourne, Trans. R. Soc., Suppl. Vol., 1905, 193, 213-26.

St. 53, 13.5 m., r. sg. sh. lith., 5 living and 1 dead.

St. 80, 16-22 m., c. s. sh., 22 coralla about half living.

St. 149, 238 m., cr. r. lith., 3 dead.

* 'Arch. Zool. Exp. Gen.' 3^e ser., V, 122 (1897).

† 'Journ. As. Soc. Bengal,' LXII, 140 et 143 (1893).

We have before us only about 16 living and the same number of dead specimens. Of these two of the living forms (St. 53) have larger and denser coralla than any we had previously seen; this is a character usually associated with shallow water. Every other costa is peculiarly thick, broad and alternates with a thinner costa near the base of which is an opening to the chamber of the sipunculid (*Aspidosiphon*), the larger chamber having its main opening on the flat base of the corallum. A sixth specimen was decalcified; and the gross features of its polyp were found to agree with Bourne's and one author's descriptions.

Heterocyathus heterocostatus Harrison.

Harrison, Proc. Zool. Soc. 1911, 1026.

St. 45, 38 m., lith., 2 living discoid growths detached from shells.

St. 72, 73 m., c. s. sh., 24, of which most are attached near the mouths of relatively large conical shells, about half living, in two cases 2 coralla to a single shell, one near the mouth and the other near the point.

St. 73, 91 m., gn. m. s. sh., 3 dead.

St. 207, 375 m., gr. br. m. pt., 9 living when obtained, all small, averaging 3.5 mm. across mouth, 4 seated on conical shells.

We must leave some future worker, with a long series, to determine whether this is a good species, a synonym of *alternatus* Verrill or a form of *aequicostatus*. Most of the larger forms have settled on elongated conical mollusc shells, and the polyps are attempting to grow over them and cover them with corallum. The young polyp settles on a shell. It then spreads, to form beneath itself a discoid corallum covered by epitheca below. When it has attained a breadth of 3-4 mm., it commences to grow upwards, its base still continuing to spread over the shell. The association with a sipunculid is subsequent, if it takes place at all.

In addition to the above there are three coralla from St. 72 attached to a conical mollusc of 7 cm. long. They are 7, 3 and 5 mm. in diameter and the two larger have broad bases. Their genus may be uncertain, but the characters of their calicles place them with *Heterocyathus*, nearest to this species.

Genus *Trochocyathus* Ed. & H.

Trochocyathus (?) *pileus* Alcock.

Alcock, "Siboga" Exp. 15, ii, 11 (1902).

Two specimens from St. 106, 183-194 m., gn. m., are referred here; they are of a dark slate colour, 17 and 13 mm. high, calicular openings 12×7 and 10×7 mm. Each has a scar of detachment at the base 2 or 3 mm. across, in which septa I are visible, and each has a very slight wing expansion here. The much higher coralla, as compared with Alcock's four specimens and especially with his figure, give a different appearance, and the theca is a very distinct structure; the columella is described in Alcock's words as "an elongated patch of pinnacles not distinctly delimited from the pali".

The outsides of our coralla were not covered by polyp tissues when dredged, whereas Alcock's references to *Tropidocyathus lessoni* suggest to us that his were; hence the costae in our specimens are less even and regular. We dislike to found a new species on two specimens only and so refer to the nearest description of a known species.

Trochocyathus oahensis Vaughan.

U.S. Nat. Mus., Bull. 59, 73, vi, 5, 6 (1907).

A specimen from St. 207, 375 m., gr. br. m. pt., identical with the above species, diameter 4–4.5 mm. Vaughan remarks that this form bears the same relationship to discoid *Trochocyathus* as *Diaseris* bears to *Fungia*; our specimen is regenerating from a sector of the original corallum, which is represented by three costæ.

Genus *Ceratotrochus* Ed. & H.*C. johnsoni* Duncan.

Duncan, Proc. Zool. Soc., 1882, 217, viii, 5–8.

Gardiner, Mar. Inv. S. Africa, III, 118, i, 5a–c, ii m (1904).

St. 106, 183–194 m., gn. m., 6 specimens, all dead.

The specimens measure 26 mm. high by calicular diameter 13 mm., 25×11 , 18×11 , 17×11 , 16×11 , 17×8 mm. Since death the surfaces of septa and costæ have been smoothed, but there is a close agreement save as to size in regard to which the several specimens so identified by one of us (J. S. G.) are intermediate. These also differ in a greater exsertness of the earlier septa, which character is shared by the present specimens.

There are also two dead specimens from St. 107, 421–57 m., and from St. 156, the latter evidently stuck in the net of the trawl from a previous haul.

Genus *Stephanocyathus* Seguenza.

Stephanocyathus Seguenza, Mem. Reale Acad. Sci., Torino, ser ii, XXI, 61 (1864).

Blastotrochus Ed. & H., Cor. II, 99 (1860).

Odontocyathus and *Stephanotrochus* Moseley, "Challenger" Report, 148 (1881).

Sabinotrochus Duncan, Trans. Zool. Soc. VIII, 320, xli, 6–9 (1871).

The justification for a separation of the genus from *Trochocyathus* lies in the sub-discoidal-form of growth, the other character mentioned by Seguenza, viz. bilobed pali, being represented in our suite of specimens by paliform lobes, usually single, sometimes double. Edwards and Haime's *T. obesus*,* the centre of the discoidal subgroup is obviously a young form of the genus. The other Eocene and Miocene species placed with it are less easy to understand, the extent of chemical changes in and depositions on their coralla being unknown.

In considering the genus it is especially necessary to remember that its corals were all attached and are attempting to assume a secondary subdiscoidal method of growth; in our species they break off while still thin and transparent before they have attained a quarter of the adult size. They show no variations dependent on feeding and movement, both of which are invariable, specific characters being fixed, as in all corals, independently of these functions. The septa dominate the growth of the calicles and the theca is built up of corallum deposited on the septal sides. All septa grow out at first horizontally from a base, represented later by a minute scar, but subsequently are built up vertically; all are very exsert in the adult and vary in size according to their cycles. Pali and

* 'Ann. Sci. nat.' 3^e ser., IX, 313 (1848).

columella are morphologically depositions of corallum on a basal disc and as such do not exist here; growths of parts of the septa, paliform lobes, and fusion of the inner ends of the septa by trabeculæ, frequently crowned by upstanding rods or corallum, replace them. The costæ on the horizontally extending base show blunt lobes or spines, always largest around the edge. *Odontocyathus* presents an extreme development of this arrangement, which undoubtedly adds to the stability of the coral when lying on the bottom; the processes are solid and well below the polyp, so that they are not in course of growth, and their presence at most is only a specific character. Our series of specimens show that *Sabinotrochus* Duncan is a young form of the genus under consideration.

We may here refer to a cornucopia-shaped coral which was dredged with our specimens from St. 159, 914–1463 m. Within its corallum-cup it is not separable from the forms of *Stephanocyathus* from the same station, and indeed it only differs in its growth-shape and in that the septa are straighter, as in *S. platypus*, and that two pairs of septa of cycle VI are present in systems on opposite sides of the corallum. It is broken in the stalk, here being about 5 mm. in diameter and it stands up 3.6 cm. above this, the diameter of the open calicle being about the same; the costæ are small, without any of the enlargement and massiveness found on the base of *Stephanocyathus*. The thickening of the stalk by epitheca is noticeable in the broken base, but the greater part of the corallum would seem to have been covered by the living polyp. The polyp was much torn and crushed, but otherwise in its gross anatomy resembled our species below. There is no trace of any attempted assumption of a disc-shape, and its interest is mainly in respect to the relationships of *Trochocyathus* and *Stephanocyathus*. It has the shape into which the latter might be expected to grow if no horizontally extending disc were formed. There is a second partially decayed and smaller specimen from St. 157, 229 m., cr. r.

Stephanocyathus nobilis (Moseley). (Pl. VI, figs. 13 and 15.)

Stephanotrochus nobilis Moseley, "Challenger" Report, 135, iii, 3 (1881).

Stephanotrochus oldhami Alcock, J. As. Soc. Bengal, LXIII, 187 (1894).

Stephanotrochus nitens Alcock, "Investigator" Exp., 18, ii, 6 (1898).

Stephanotrochus weberianus and *sibogæ* Alcock, "Siboga" Exp., 24, iii, 22, 23 (1902).

Stephanotrochus campaniformis Marenzeller, "Valdivia" Exp. VII, 302, xviii, 20 (1904).

St. 118, 1789 m., gl. oz., 4 living, 1 having been decalcified, young.

St. 119, 1207–1463 m., 4 living, 8 dead varying from 12 to to 38 mm. diameter.

St. 152, 609–915 m., gn. s., 2 living.

St. 158, 786–1170 m., 2 living, 2 dead, young.

St. 159, 914–1463, 11 living, 7 having been cleaned.

St. 185, 2000 m., gn. m., 2 living (1 decalcified and 1 cleaned).

Adults, over 3 cm. in diameter: corallum dense and massive in appearance, varying from flat-bottomed saucer- to bowl-shape. Base rounded to quite flat, with a central scar of former attachment, 1–2 mm. in diameter, where distinct showing 4–6 septa. Base set with 12–24 coarse costæ, each with about 6 spines, which increase in size from the central scar to the periphery, where they may stand out almost horizontally, thus adding to the steadiness of the corallum on its base.

Side walls varying from about 60° to vertical in their rise from the base, generally rather hollowed out where the peripheral spines of the basal costæ are strongly projecting;

the side wall below the polyp tissue covered by a shining epithecal deposit, the polyp not extending in life more than 2-3 mm. down the outside of the thecal wall. Costæ existing here corresponding to all the septa and varying correspondingly in thickness, low, unspined and slightly to completely obliterated by the epithecal deposit.

Larger septa (I and II) varying up to 7 mm. in exsertness; all septa standing up well above the theca, the edge of which may be even in height or rise higher between the larger septa and those next on either side. Deeper the septa sloping inwards almost vertically, thus giving an open area in the centre of the corallum, about half its diameter; in this inside slope edges of larger septa (I and II) entire; septal cycles III and IV complete, also about half of V, septa of cycle IV frequently bent towards and joined to those of III by trabeculæ.

Paliform lobes of septal cycle I and II usually largely merged into a columella-like mass in centre; septa of cycle III narrower, each generally with a conspicuous tooth, these also usually found on cycle IV where V is present, sometimes double or bifid, especially on III.

Columellar area very variable, from a mass of upstanding rods a quarter the diameter of the calicle to an absence of any area except what may be due to the low paliform lobes of the septa I and II, the whole variation largely due to a secondary thickening of the corallum in this part, together with upgrowth from the trabecular junction of the septal ends.

Young forms: saucer-shaped without vertical walls, 12 spined costæ below radiating from the scar, greater part here covered over by epitheca. Septa very exsert, edges rather irregular, even in smallest (10 mm. diameter) with about half the septa of cycle IV; those of I and II thickened and fused in the centre of the calicle, where there is a secondary deposition of corallum over the scar. Septa of cycle I distinct, cycle II often joined by the neighbouring pair of III. When about 20 mm. diameter paliform lobes distinct, but pseudo-columella not yet formed.

The method of growth in the species is such as to produce a low saucer-like disc, with upstanding septa until a size of nearly 30 mm. diameter is attained, when the polyp commences an upward growth and forms a vertical surrounding wall (theca), its deposition proceeding from the sides of the exsert septa. The polyp is seated on the top, no part of the base and only 1 or 2 mm. of the surrounding wall being clothed by the polyp tissues. The epitheca is largely dissolved off the base of adult forms, where presumably they are lying on the mud surface, and chemical changes give the formerly translucent corallum an opaque appearance. There is much variation in the deposition of the skeleton within the calicle and hence in the resulting massiveness of its appearance. The septa may be greatly thickened, especially their inner paliform parts, the appearance of a central flat columellar area being due to these or to upright pillars of varying sizes (usually with granular surfaces) arising on the solid base or on trabecular junctions between the septal ends, more often perhaps to a mixture of both. The area is broadest where the surrounding wall is vertical, becoming greatly reduced where the whole slopes in gradually, as is well seen in Moseley's type-specimen, which is only slightly more conical than one form (living) from St. 119.

The 8 dead specimens represent a series in size from 12 to 37 mm. diameter. They have lost all their translucency and are quite opaque. The epitheca has mostly disappeared, while all spines of the costæ, paliform lobes, columellar rods and all trabecular corallum

is greatly reduced, being largely removed. They confirm the preceding account of the structure founded on the living coralla.

Of the species in our synonymy *S. nitens* Alcock (off Goa, 1480 m., 1 specimen) is clearly the same species; the statement that its surrounding wall is free from epitheca is almost certainly incorrect. *S. oldhami* Alcock (Laccadives, 1272 m., 1 specimen) falls within the limits of variability, especially in respect to its columellar region. Both *S. sibogæ* Alcock (E. Indies, 1301 m., 1 example) and *S. weberianus* Alcock (E. Indies, 828 m., 1 example) fall within our range. The former is supposed to be aberrant in the number of its septa, but, if the artist's figure be compared with that of the companion species, it becomes clear that there are several ways of counting the septa, the fluctuations in size of septa being correlated with growth, which here is unusually conical. *S. campaniformis* Marenzeller (South Atlantic, 981 m., 3 examples) is merely a corallum which has grown up into a rather rounded shape with reduction of columellar structures.

As to the other living species of the genus Capt. Totton lent me 5 specimens from the British Museum of *S. (Odontocyathus) coronatus** Moseley, all Atlantic, "Challenger", 390 fathoms. At the edges of their basal discs they have large costal spines, extending out horizontally in a circle, in some more marked than in Moseley's figured form; the theca above is overlaid by epitheca. As this condition seems to be general, the species must be retained.

S. platypus Moseley† (off New South Wales, 410 fms., 2 specimens dead and somewhat decayed) has a low vertical wall, the enormously exsert portions of its larger septa conspicuous, otherwise thin septa and theca. Paliform lobes are worn down, but recognizable on some septa of cycles III and IV. If decay here, as in our suite of dead *S. nobilis*, has reduced or removed costal spines, septal teeth, trabecular septal junctions and central columellar parts, these are older or less rapidly grown specimens of *S. diadema* Moseley‡ (off Pernambuco, 695 fms., and Azores, 1009 fms.). Of two Moseley specimens of *S. diadema*, the smaller has not got that septal fusion which is such a marked feature of the larger form; neither have as yet established their vertical growth. A West Indian specimen, 1200 fms., from the Agassiz Museum of *S. diadema* before us is 46 mm. diameter and is a thin transparent saucer, which has as yet scarcely commenced to grow vertically. The primary septa are separate, but septa III fuse with II, IV with III, and there is generally a line of spines representing V often fusing with IV. The large columellar area is much filled in with secondary corallum and has a rough surface. *S. discoides*§ Moseley (off Pernambuco, 675 fms.) is probably a very young growth of the last species; as usual immature forms more closely resemble one another than do adults.

S. moseleyanus Sclater§ (Faroe Channel, 570 fms., 1 specimen living) may be regarded as a slightly older form of *S. diadema*, both being Atlantic and of the same shape, but all septa of *diadema* are joined to their neighbours of higher orders, whereas in *moseleyanus* cycle IV only join cycle III where cycle V is developed (p. 131), and this is what is also found in *nobilis*. At present we cannot assign the value to be placed for specific purposes on each structure in the coral skeleton and this is especially the case in respect to trabeculæ.

* This is supposed to be a synonym of *Trochocyathus coronatus* Pourtales, 'Cat. Mus. Comp. Zool.' IV, 14, vi, 16 (1871), but the description is insufficient and the specimen was dead and bad.

† "Challenger" Report, pp. 151-155 (1881).

‡ "Challenger" Report, pp. 151-155 (1881).

§ 'Proc. Zool. Soc.,' 1886, 128, xii-xiv.

Indeed, we are led to wonder whether all the above forms do not in reality belong to a single cosmopolitan species.

S. explanans Marenzeller* (off S. Africa, 231 and 507 fms., a short suite of specimens shown in the figures) is smaller than *S. nobilis* and its septa are less exsert. Its basal disc shows 6 equal costæ instead of 12, but in all other characters it seems to fluctuate as the forms of *nobilis* before us.

Odontocyathus sexradiis and *stella* Alcock† (East Indies, 469 m., 1, and 411 m., 1 dead and broken) almost certainly represent the same species. They are dominated by 6 primary costæ growing out from the edge of the disc as spines, on which the corallum stands. Allied here must be *Stephanotrochus spiniger* Marenzeller‡ (Japan Seas, no depths).

The polyps of all our preserved specimens were shrunken, but similarly coloured. The outside wall varied from a dark purple-brown to a light tinge; next a pale blue ring close to the tentacles, which were deep blue and semi-transparent. The oval disc was dark purple-brown, with a narrow pale blue rim round the circular and open stomodæum. The tentacles over the septal ends corresponded in number and size with the same.

Capt. Totton has also placed in our hands a specimen 40 mm. in diameter from Timor Sea, 900 fms., presented to the British Museum by the Eastern Telegraph Co.; it was apparently recently dead. The rather pointed base was greatly decayed, epitheca dissolved away, as well as part of the theca and all costal ridges. All the inner parts of the calicle are very smooth, septa untoothed save for single paliform lobes belonging to septa I, II and III, those of I and II with some upstanding rods forming the columella. The septa are less exsert than in any specimens of *S. nobilis*, but it does not appear to us beyond the range of that species.

Genus *Sphenotrochus* Ed. & H.

Sphenotrochus intermedius (Munster).

Duncan, Trans. Zool. Soc. VIII, 320, xli, 1-5 (1873).

Four coralla of different sizes from St. 178, 91 m., c. gn. s., are identical with the description of the specimen so identified by Duncan save that the columella is a single plate, dented in the centre. The largest specimen is 5 mm. long, and the length of the calicular opening 4 mm. by 2 mm. broad.

Genus *Tropidocyathus*.

Ed. & H., Ann. Sc. nat. ser. 3, IX, 326 (1848); Cor. II, 57 (1860).

The genus was founded for *Flabellum lessonii* Michelin, and in the 'Histoire' *T. bougainvillei* was described. Duncan§ called *Tropidocyathus* a subgenus of *Trochocyathus*, and we suppose the "basal expansion" of the corallum to refer to the "bordure cariniforme". *Thecocyathus*, also made a subgenus, is quite distinct, possessing an epitheca. Pending the revision of the family we regard all three as genera, defining

* "Valdivia" Exp., VII, 304, xviii, 19 (1904).

† "Siboga" Exp., 24, iii, 20, 21 (1902).

‡ 'Ann. K. Nat. Hof.' Wien, III, 20 (1888).

§ 'Journ. Linn. Soc.' XVIII, 22 (1884).

Tropidocyathus as free, compressed, no epitheca, outside covered evenly by costæ, pali before all septa except last cycle, and columella of twisted rods.

Tropidocyathus lessonii Michelin* has "une forte bordure cariniforme"† or "lateral costæ expanded to form a pair of wings",‡ somewhat in the manner seen in *Platytrochus* and this is the only difference from *nascornatus*. This remark also applies to *T. bougainvillei* Ed. & H. *Trochocyathus pileus* Alcock§ differs from our species only in absence of regular asexual reproduction, the septa of cycle IV frequently joining to those of III.

Tropidocyathus nascornatus n. sp. (Pl. V, fig. 10.)

St. 104, 207, m., gr. gy. s., 3 in spirit.

St. 105B, 238–293 m., gn. m., 27 dry, 10 in spirit.

St. 106, 183–194 m., gn. m., 26 dry, 21 in spirit.

St. 107, 421–457 m., 1 dry. Total 88; all living when obtained.

All the coralla pale orange in colour. Primarily shaped coralla—few in number in a suite of 88 specimens—compressed cones with the septa and theca standing up slightly higher at the centre than the ends; at each end an especially high costa of cycle I. Whole corallum completely covered by polyp-tissues, and hence no epitheca and no clearly recognizable scars or indication of former attachment.

Secondary coralla—over 90%—regenerated individuals, mostly grown from vertically split-up fragments from any part of the primary form, the smallest such pieces with about 8 septa; many fragments transversely broken as well when the regenerated coralla grow out on all sides, the new polyps utilizing the original costæ, septa and mesenteries. Shape of regenerated corallum always endeavouring to approximate to that of a compressed cone, but necessarily great irregularity, especially in the basal region and in the shape of the calicular opening.

Costæ completely covering the whole outer surface, equal in size, finely granular, with saw-like edges.

Septa: cycles I–IV complete; terminal septa belonging to cycle I; between these terminal septa and neighbouring septa of cycle II septa of V commonly present, often complete in these half systems. Septa of I and II equal, broader, thicker and markedly exsert, those of II standing up higher than of IV and the thecal edge between correspondingly higher. Septal edges not toothed, sides with distinctly spined lines of growth leading to their edges, whole looking echinulate on surface view into the calicle.

Paliform structures of I and II small and frequently not distinct from columella; those of III and often IV, when present, conspicuous flattened plates.

Columella upstanding rods, tending to be flattened along the length of the central valley, the bottom of which is commonly about 5 mm. below the upstanding sides of the corallum. In secondary coralla the whole often more open, broader columella, finer rods, highly variable with form of growth.

Largest flattened cone 20 mm. high, calicle 11 mm. broad by 16 mm. long; mostly much smaller.

* 'Revue Zool.' 119 (1842).

† Ed. & H., 'Ann. Sc. Nat.' ser. 3, IX, 326 (1848).

‡ Alcock, '“Siboga” Exp.' 37 (1902).

§ *Loc. cit.* 15 (1902).

This species differs from all others of the genus in its extraordinary method of asexual reproduction, the coralla breaking up and its pieces regenerating polyps and coralla. With a large suite of specimens before us we cannot regard this as an accidental phenomenon. Pourtalès* briefly referred to a similar method in *Leptocyathus stimpsonii*, nov., from 60 fms., West Indies, and figured one regenerated specimen; the species here is a circular, more or less discoidal or cup-shaped form, with subequal toothed septa, pali II prominent.

Tropidocyathus lessoni (Michelin).

Michelin, Revue Zool. p. 119 (1842); Magaz. de Zool. pl. 6 and description (1843); Ed. & H., Ann. des Sci. nat. 3^e ser., IX, 327 (1848).

Alcock, "Siboga" Exp., 17, ii, 14a (1902).

There are 4 specimens of this species from St. 103, 101 m., c. s. sh., which agree with the above, the largest about the size of Michelin's specimen, which was 10 mm. high, calicle 10 by 6 mm.; wings and columella agree with his figure. Alcock's Siboga specimen is figured with a flattened columella divided into three, not the "papillose" type, but we think it is a rather older corallum.

Genus *Discotrochus* Ed. & H.

Discotrochus dentatus Alcock.

"Siboga" Exp., 27, iv, 26 (1902).

St. 89, 193 m., s. sh. r., 1 dead.

St. 145E, 494 m., 3 living.

St. 149, 238 m., cr. r. lth., 1 living.

St. 157, 229 m., cr. r., 1 living and 2 dead.

All specimens have a distinct scar of attachment 2-3 mm. across, subsequently overgrown by the polyp-tissues. Living specimens show the corallum translucent, but thick, while in dead specimens it is opaque and thus appears to be thickened in septa and costæ, and at the thecal edge; this adds to the coarse look of the already relatively massive skeleton. Alcock's figure is distinctly that of a dead specimen, the living forms having more differentiation of septa and of costæ, and their outer ends over the theca are more exsert. The columella varies considerably from a smaller number of larger rods than shown in Alcock's figure to an area looking lightly packed with coarse grains. The diameters of the disc of the largest living and dead forms are 20 mm. and 23 mm.

The species described by Alcock as *D. investigatoris*† was obviously founded on a young and dead corallum which had been chemically altered as above; it probably belongs to this species, but, as this cannot ever be determined, unless a long series is collected, it had better disappear from literature.

Genus *Deltocyathus* Ed. & H.

The genus is well marked, a chief and unalterable character being the fact that the corallum was deposited entirely within the polyp, which is not known ever to have

* 'Cat. Mus. Comp. Zool.' IV, 12, iii, 1-3 (1871).

† 'J. As. Bengal.' LXII, 142, v, 5 (1893).

been attached in the mode of *Fungia*. All authors who have described its species agree as to this except Lindstrom,* who assumes a former attachment. This question is difficult, because without attachment or some invagination at the base of the young polyps, it is hard to understand how the ectoderm-formed corallum can have originated. We have many small specimens before us, especially of *D. minutus* nov, and one of us (J. S. G.) has examined others in respect to this question both at the Smithsonian Institute and the Agassiz Museum of Zoology; unfortunately they are devoid of polyps.

So far as we can judge the septal growth dominates in development, the thecal part formed by thickenings on the septal sides; this theca causes one part of the radiating plates to be called septal and another costal. Clearly all septal "fusions" must be ectodermal outgrowths from the earlier cycles at right angles to the individual septa, meeting similar outgrowths on the later cycles when formed. On this plan pali and columella, which should grow up on a basal plate, cannot exist—and indeed all such appearances in the species we have before us are equally well described as paliform lobes of septa. We state the morphological problem in the hope that one day it may be solved by a study of development; there must have been an early invagination to produce the corallum.

Whilst there is no trace of a basal scar in the majority of our specimens, we are confronted with a few amongst our *D. andamanicus* in which may be imagined a faint trace of a possible basal attachment. In some this part of the corallum is masked by chemical changes that inevitably occur in any dead part of the corallum. In any case it is unnecessary to assume the formation of a basal plate of attachment, an epithecal formation, especially since Noboru Abe's study of the "Post-larval Development of *Fungia actiniformis*", wherein he shows that 6 endosepta begin to form within the planula on the seventh day after extrusion from the mother and that there is no suggestion of any further coral structures until the seventeenth day.†

As to the species, it is clearly useless to describe the same without a suite of specimens, and we apply this to *D. ornatus* Gardiner.‡ The type-species of the genus is *D. italicus* (Mich.) from the miocene, and into this Pourtalès subsequently absorbed his *D. agassizii*. Moseley's "Challenger" specimens§ from the Indo-Pacific cannot be accepted as *D. italicus*, one being attached and the other considered as doubtful by Moseley; neither of these specimens are in the British Museum and are probably non-existent. Alcock|| identifies 5 specimens from the East Indies (204–794 m.) as *italicus*, but does not discuss its relationship to *andamanicus*; he gives full references—and also to its synonym *D. agassizii* Pourtalès. We feel uncertain whether the living species is identical with *italicus* or should more properly be termed *agassizii*. We have not the advantage of "1000 specimens" from one locality (West Indies) for study, as Pourtalès had, and must hence accept his species with its three or four forms of growth. Of 9 specimens before us from the West Indies, 4 belong to var. α , 2 to var. β , and 3 to var. δ . They would be regarded as distinct species had we not the assurance otherwise of Pourtalès.

* 'K. Sven. Vet. Akad.' XIV, 10 (1877).

† 'Palao. Biol. Sta.' I, 73–93, 1937. The growth curve of this larva shows a rapid rise in the first six days, slowing rapidly as soon as the skeleton commences to form.

‡ Willey's 'Zoological Results,' II, 163, xx, 25 (1899).

§ "'Siboga' Exp.' p. 19 (1902).

|| "'Challenger' Rep.' 147 (1881).

Deltocyathus andamanicus Alcock.

"Investigator" Report, 16, i, 5, 5a (1898); Vaughan, U.S. Nat. Mus., Bull. 59, 71, vi, 4, 4a (1907).

St. 119, 1207-1463 m., 2 living.

St. 149, 238 m., cr. r. lth., 5 living.

St. 180, 397 m., gn. m. s., 6 living.

Our series vary up to 15 mm. in diameter and are much less massive, though larger than any West Indian *italicus* that we have seen. For the species before us we have Vaughan's support from actual comparison with *italicus*, for he remarks "no evidence of intergradation was found".

The costæ do not meet in a point on the underside of the disc in adult forms, but run into a small rounded area covered with minute spines. There is no justification for regarding this in our specimens as the scar of a former adherence which it may superficially resemble. This view is supported in that 6 small forms of about 3 mm. diameter, St. 180, have no scar, assuming that they are correctly ascribed. The pali or paliform lobes are not well marked in these young specimens.

The septa are much thicker and more even than in *D. murrayi* nov. or *rotulus* (Alcock).

Deltocyathus rotulus (Alcock).

Trochocyathus rotulus Alcock, "Investigator" Rep. 16, vi, 1, 1a (1898).

Deltocyathus fragilis Alcock, "Siboga" Exp. 21, ii, 15 (1902).

St. 26, 2312 m., sft. gy. w. m., 1 dead.

St. 34, 1022 m., gn. m., 1 dead.

St. 119, 1207-1463, 4 living, 3 dead.

St. 145, 510 m., 3 living.

Alcock's descriptions and figures are excellent and apply well to our 7 living specimens, but why he placed them in two genera and two species we cannot conceive. The points from which the costæ radiate on the undersides of the discs are white and opaque, apparently killed where they lay on the bottom; there is no trace of former adherence. The symmetrically-scalloped edge to the theca and a certain irregularity in height of the same is a most conspicuous feature, showing the formation of the theca by septal thickenings.

The exsert ends of the septa are not nearly so prominent as in *D. murrayi* n. sp., to which the species in texture bears a close resemblance. Alcock's description of the 18 principal and 54 other septa is accurate for the larger forms, but our dead specimens enable us to see that this is a growth feature, 24 septa of cycle V not being formed. The 18 paliform lobes of the larger septa are conspicuous and long.

The columella is as described, but in one of our specimens, owing to the thickening of the upstanding ends of the trabeculæ, looks papilliform.

We consider that *D. fragilis* was a specimen of *D. rotulus* that had died recently; for in all features Alcock's figure and description of *D. fragilis* agrees with our dead specimens, except in the thin vitreous texture of the corallum. In all our dead specimens surface chemical deposition was considerable.

Deltocyathus murrayi n. sp. (Pl. VII, fig. 16; Text-fig. 3.)

St. 26, 2312 m., sft. gy. w. m., 10 living and 3 dead.

St. 59, 1948 m., sft. gn. m., 1 dead.

St. 185, 2000 m., gn. m., 2 living and 5 dead.

Corallum of a thin vitreous texture, discoid to saucer-shaped, round or slightly oval. Thecal edge regular without indentations, crossed by the septal edges, the 12 larger septa extending horizontally for 2 mm. beyond the theca. Costæ thin, 12 prominent

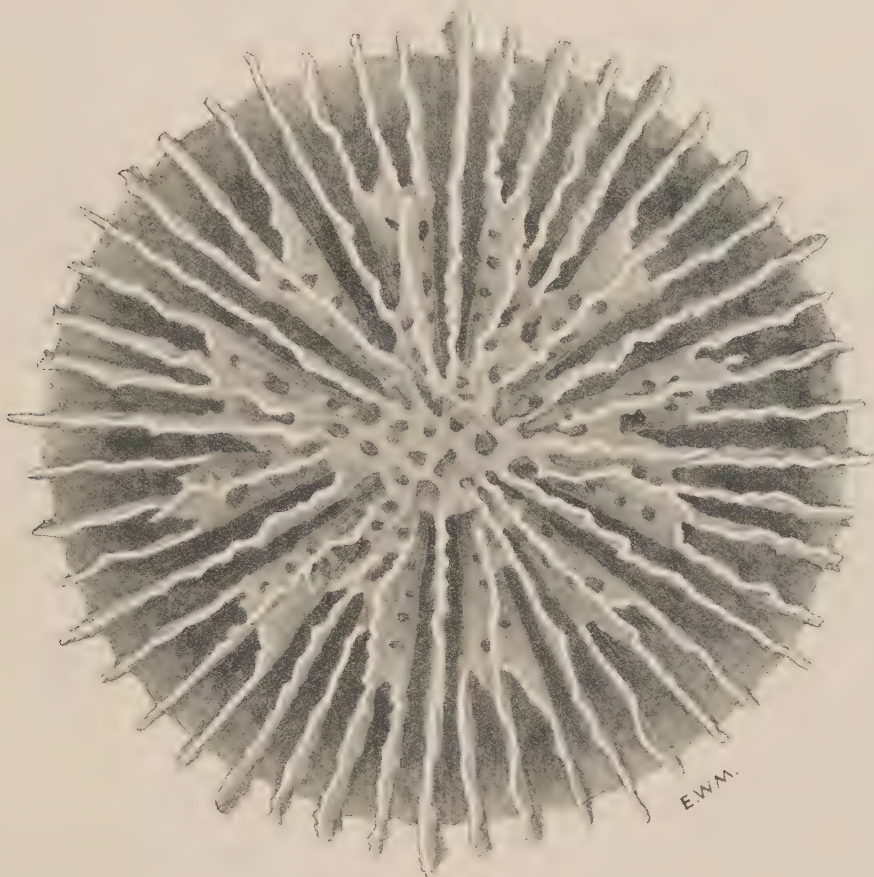


FIG. 3.—*Deltocyathus murrayi* n. s.p. $\times 6$.

and relatively high, extending to a central point, with others of the third and fourth cycles, similar but lower and not reaching the centre; edges of all finely toothed.

Septa: four cycles of the regular generic character, viz. cycle I separate reaching the centre, cycle IV joined to III and III to II; all remarkably thin, irregularly serrated on their edges, with growth-lines as ridges on their faces.

Paliform lobes elongated, rather variable in size, but always thin and at internal ends of septa I–III, each marked off by a notch, best viewed at an angle of 45° .

Columellar region: trabeculae joining the septa together to form a spongy mass, with low twisted upstanding processes, the whole broadening with a more completely discoidal nature of the whole corallum.

Size varying up to 21 mm. diameter.

None of the specimens has any trace of any former basal attachment ; this is perhaps correlated with the muddy bottom on which they lay. On their upper surfaces they likewise show no distortion and in consequence a complete regularity of septa. There is no filling-up of the corallum between the septa, and any thickening of theca and septa, subsequent to their formation, is very slight. In large specimens, septa of cycle I stand up for 3–4 mm. above the theca, and there is a certain irregular appearance which helps to separate the species from *D. rotulus* (Alcock).

Deltocyathus lens Alcock. (Text-fig. 4.)

“ Siboga ” Exp., 19, ii, 16 (1902).

St. 104, 207 m., gr. gy. s., 11 mostly alive.

St. 126, 209 m., lt. br. m. sh., 1 alive.

These agree in all respects with this species, which in shape is much less discoid than most species of the genus. None of the specimens, including a baby of less than 2 mm.—the largest is 8 mm. across—show any trace of former adherence. Since the paliform lobes are shown as too massive in Alcock's figure and those internal to septa III are not represented, an additional figure may be helpful. One of our specimens seems to be the regrowth of a sector of a disc which split up from the centre, as *Diaseris* does.

Alcock states : “ Costæ all equal and all distinct from calicle to base, sharply salient and elegantly serrulate.” There is a certain difference in exsertness of the different cycles of septa in his figure, and the costæ of our specimens corresponding to septa I and II are more prominent and thicker.

Deltocyathus minutus n. sp. (Text-fig. 5.)

St. 7, 300 m., sft. y. m., 23 specimens, alive but much damaged by mud.

St. 103, 101 m., c. s. sh., 1 dead.

St. 206, 256 m., gr. br. s. m. r., 33 specimens, all alive when obtained.

St. 209, 366 m., gr. br. m. r., 1 living.

Corallum a flattened disc when young, thickening almost to an inverted dome-shape, which is correlated with the growth of septa. General appearance dense, almost massive. Undersurface with no trace of former adherence, central part smooth and rather solid. Costæ low, thick, covered by granules and very even in size.

Septa : Equally and slightly exsert over the theca, where they pass into the costæ ; in smaller specimens cycles I, II, III only, III joining II ; in larger forms never more than half the septa of IV found ; all relatively thick and granulated with narrow interseptal loculi ; all evenly upstanding on the peripheral half of disc.

Pali (or paliform lobes) rather low, very varied, from quite distinct at inner ends of septa II and perhaps some low before septa III, where IV present, to scarcely distinguishable pillars.

Columella relatively small, a few rods often placed as if having a paliform connection with septa I.

Size 1·2–5 mm. diameter.

Deltocyathus varians n. sp. (Pl. VI, fig. 14; Text-fig. 6.)

St. 176, 655-732 m., gn. m. s., 1 complete corallum, 1 nearly so, 2 halves and 1 piece.

Corallum discoid with no sign of former attachment tending to be curved up at the edges, with total height varying up to 5 mm., whole tending to split from the centre with subsequent regeneration.

Costæ radiating from a central point, well marked and rather thin ridges, with granular edges; quite distinct and clearly defined sizes corresponding to cycles of septa.

Thecal edge irregular, extending further between the exsert ends of the larger septa and those next to the same. Septa 12 reaching to the central hollow; between each of these a septum extending equally far in with a pair of septa converging and fusing to same

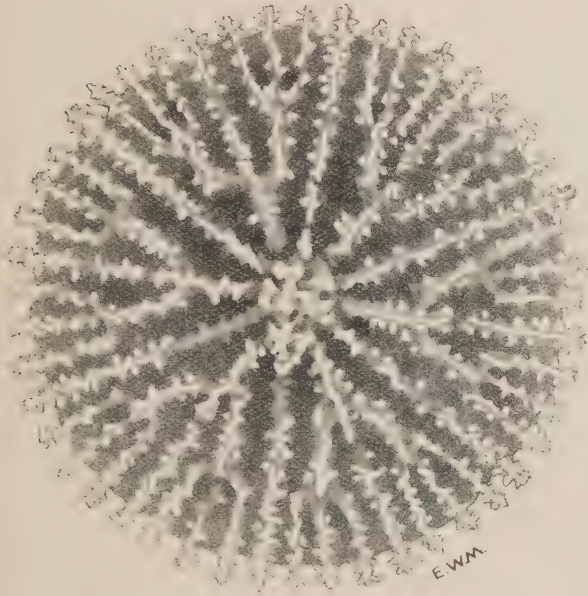


FIG. 4.—*Deltocyathus lens* Alcock. $\times 12$.

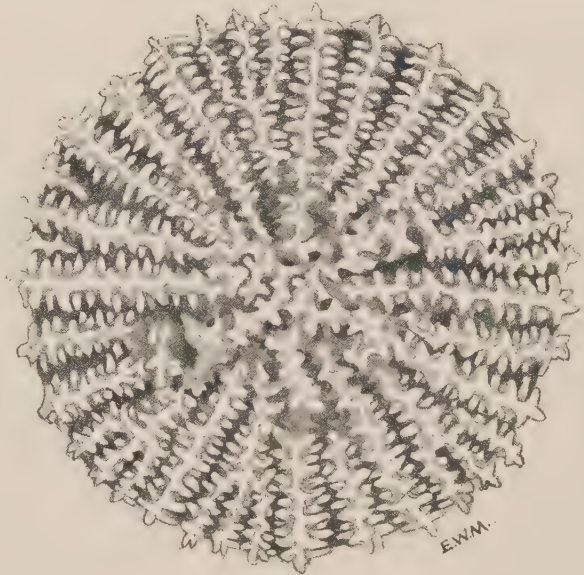


FIG. 5.—*Deltocyathus minutus* n. sp. $\times 25$.

in the outer half of each radius, the central member of each such group belonging to the most exsert series of septa and having the largest costæ, these septa generally having a flattened upstanding tooth just internal to the septal fusions.

No well-defined pali and no true columella, but in place a number of fine teeth, on the central parts of the septa or on trabeculæ from the same, giving a mass of fine rods.

Size up to 14 mm. diameter.

We might describe this coral as having 12 septa (I and II), then 12 (III) with chevrons produced by fusions with septa IV—these are more peripheral than in many species of *Deltocyathus*—and a flattened tooth internal to the same. Then the mass of fine rods in the centre would be supposed to include pali of I and II. The splitting-up and regeneration of the disc has not previously been described in the genus and is the main justification for suggesting a name on material admittedly inadequate. The actual parts of the corallum are firmer and thicker than in *Fungiacyathus*,* but this may be partially a matter of the depth in which the coral lived.

* Vide p. 200.

Genus *Fungiacyathus* Sars.

G. O. Sars, Remarkable Forms of Animal Life, Christiania, 58, v, 24-32 (1872).

This genus appears to us to be a turbinolid. Its types, however, bear a resemblance to *Fungia*, but show no trace of its early development. These were four specimens obtained by the elder Sars from 300 fathoms off soft clay on the Norwegian coast, and three are illustrated by his son. All these are irregular in outline, and this character is only to be understood on the view that they represent discs that have regenerated from pieces of the split-up corallum as seen in "*Diaseris*", or in another shape in the *Tropidocyathus*

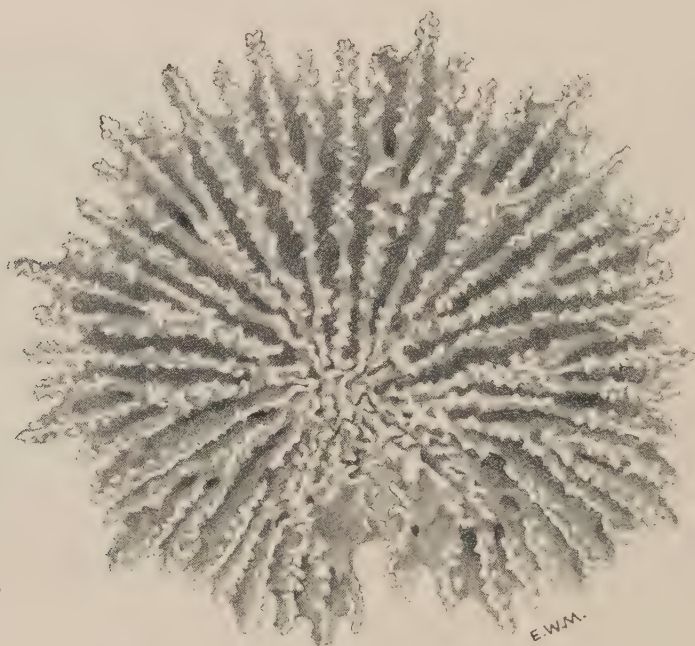


FIG. 6.—*Deltocyathus varians* n.sp. $\times 6$.

nascornatus described in this report, the same specific designation being equally appropriate below.

The Director of the Museum at Oslo kindly lent us the fourth and largest specimen of the type-species, *F. fragilis*, which had been preserved in spirit; it proved the excellence of Sars' description. Synapticular junctions do not seem to be present between the septa, so that it represents a genus apart from *Bathyactis*, although it resembles the latter in its thin corallum. The specimen consists of three pieces of a single disc of about equal size, now held together solely by the polyp-tissues; indeed, it was in process of splitting up to form three coralla. Its flat, thin and light skeleton separates it from the species now described as new.

The descriptions of two supposedly new species, which follow, are short, the figures being integral parts of their descriptions. The coralla of these species are imperforate, their interseptal spaces completely open to the base, with little or no deposition of

corallum on the theca after it has been formed. The septa neither bend towards each other nor fuse, and there is the minimal trabecular formation in all parts.

Fungiacyathus nascornatus n. sp. (Pl. VII, figs. 19, 20.)

St. 176, 655–732 m., gn. m. s., 4 and 3 pieces.

St. 185, 2000 m., gn. m., 4 and 2 pieces.

St. 72, 73 m., c. s. sh., 2 pieces.

Corallum evidently somewhat discoid when young and free, then splitting up from the centre outwards, each piece regenerating a calicle, which tends to grow upward, becoming cup-shaped, though always spreading outwards. Whole enclosed in the polyp-tissues. No evidence of former adherence.

Costæ granular, rather thick and even, though cycles may be distinguished.

Septa varying up to 2 mm. exsert and rising up to 4 or 5 mm. above the theca, in different systems up to 4 cycles, no fusion of septa of lower to higher orders; growth-lines and a certain spinulose character on the septal sides with edges tending to be wavy.

No pali and no columella, but in the regeneration of the central part of the corallum fine trabeculæ tending to grow upwards as fine curled rods.

Size up to 25 mm. in diameter.

The above description has been founded on the specimens from St. 176. Those from St. 185 are of half the size, their coralla more delicate, all dead below where mud-covered and tending to assume an open cup-shape with consequent variation in the septa. That from St. 72 is a half corallum of small size, rather more massive than last.

Fungiacyathus sarsi n. sp. (Pl. VII, figs. 18, 19.)

St. 141, 44 m., c. s. sh. cr., 6 living.

Corallum discoid and flat, almost circular, frequently splitting from the centre outwards and regenerating almost flat discs. Whole corallum enclosed within the polyp, without evidence of former adherence.

Costæ thin, even, low ridges radiating from the centre, cycles mainly traceable from the exsert septal ends.

Septal cycles difficult to distinguish, up to 24 larger and about 1 mm. more exsert, rather irregular, all joined by a thin imperforate theca; usually three between neighbouring larger septa, last cycle very distinctly lower and thinner; on account of mode of growth edges of septa zigzag; all except last size running into the central space with a series of low spines filling the same.

Sizes varying from 13·5 to 17 mm. in diameter.

All the specimens would appear to have been regenerated coralla and hence might not show any traces of former adherence. They are much stronger and firmer coralla than *nascornatus*, but unfortunately the polyp-tissues of both species were destroyed by the sand or mud which was brought up with them. All specimens are figured; the regenerated part of one is curiously open in the centre.

VI. CLASSIFICATORY TABLE OF THE SIMPLE TURBINOLIDÆ HAVING SPECIES STILL LIVING.

TURBINOLIDÆ Wall thecal; septal loculi open to base; simple corallum	{	tall or conical; columella	{	absent; the pali	{	absent	<i>Desmophyllum.</i>			
				twisted ribbons; pali		1 crown	<i>Conocyathus.*</i>			
						1 crown	<i>Caryophyllia.</i>			
				fascicular; pali		2 crowns	<i>Trochocyathus.</i>			
						before all septa except last cycle; corallum	fixed	<i>Paracyathus.</i>		
							compressed, free	<i>Tropidocyathus.</i>		
							absent; free	<i>Ceratotrochus.</i>		
						lamellar; pali absent; free	<i>Sphenotrochus.</i>			
				broad; free or attached shell, often with <i>Aspidosiphon</i>; pali before all cycles.		{	well developed; septa	penultimate bending towards next highest cycle	<i>Stephanocyathus.†</i>	
								of last two cycles deltoid	<i>Deltocyathus.</i>	
								absent; septa	straight with thick blunt teeth	<i>Discotrochus.</i>
									straight and untoothed	<i>Fungiacyathus.</i>

(In the above Table all the genera in the adult state from *Tropidocyathus* downwards are unattached; this we regard as a secondary character and not indicative of the past evolution.)

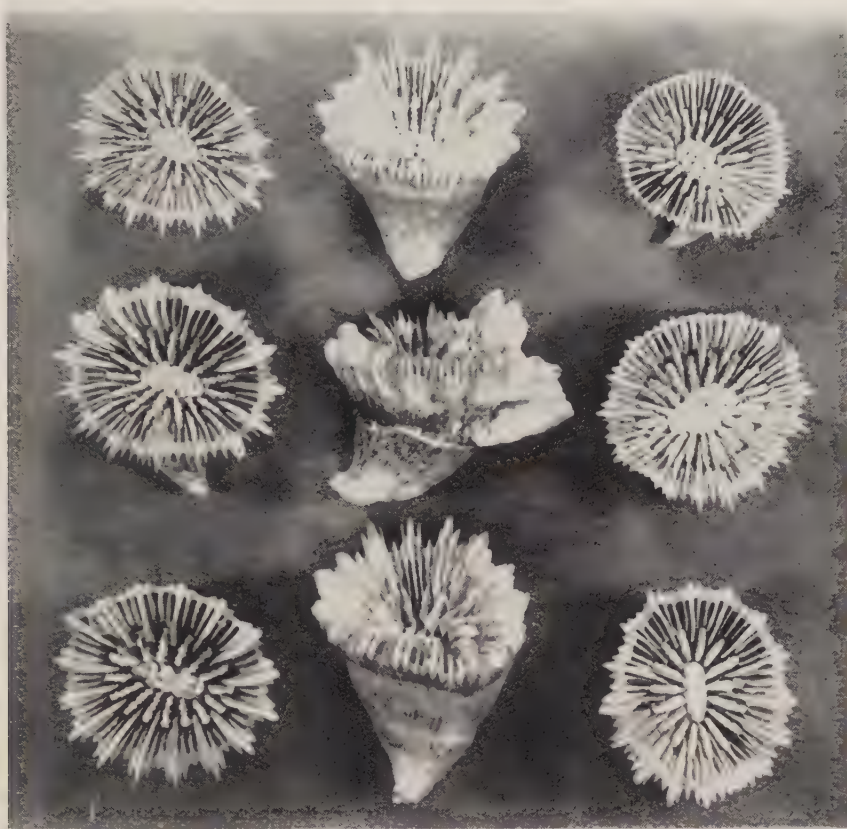
* We have not had the privilege of examining this genus, a living species of which is figured by Duncan in 'Proc. Zool. Soc.,' 1876, 431, xxxviii, 1-3, locality New Zealand. Harrison, 'Proc. Zool. Soc.,' 1911, 1031, refers this species to *Trematotrochus*, to which he gives references; assuming Duncan's description to be correct, we doubt this identification and the reference of the genus to the Turbinolidae.

† Gravier ('Res. Camp. Sci., Monaco,' LV, 1920) under name *Stephanotrochus* should be consulted, his beautiful figures of this and other genera examined. We have not discussed his report in our text, differing from him in method of approach and having a strong objection to growth-varieties. Someone will perhaps examine the British Museum and Moraco specimens together. Gravier's genus *Peponocyathus* should perhaps be inserted in the table above, but we have not examined it. Its coralla are of a peculiar gourd-shape, straight septa, pali, etc., and are clearly related to *Deltocyathus*.

DESCRIPTION OF PLATE I.

FIG. 1.—*Caryophyllia clavus* Scacchi. × 1.

FIG. 2.— „ *grandis* n. sp. × 1.



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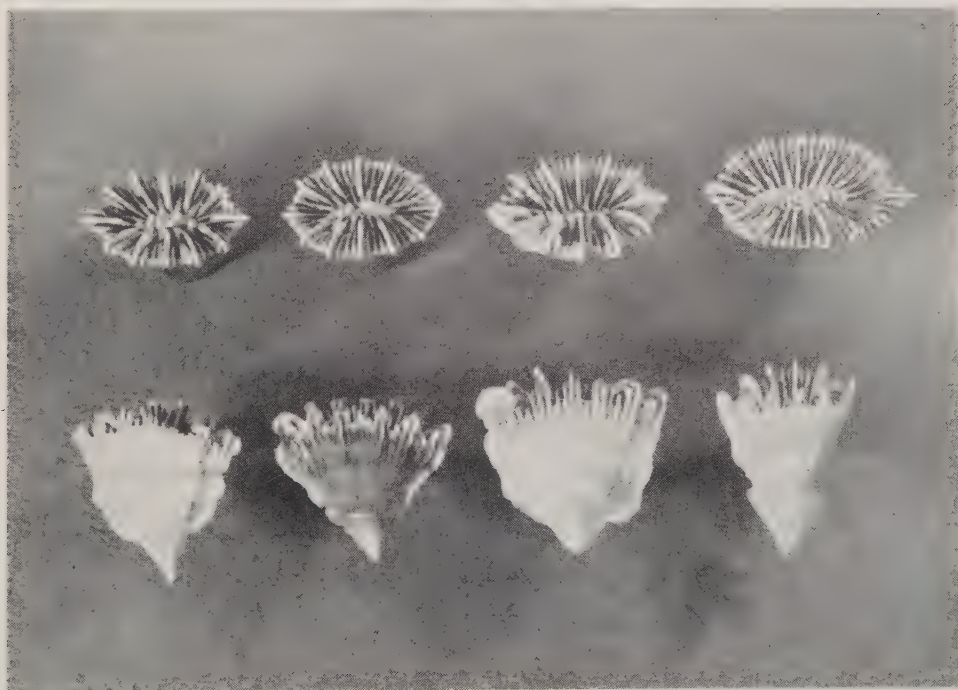
DESCRIPTION OF PLATE II.

FIG. 3.—*Caryophyllia sewelli* n. sp. $\times 1.25$. The central coralla top and bottom were alive when obtained.

FIG. 4.— „ *compressa* n. sp. $\times 1.25$.



3



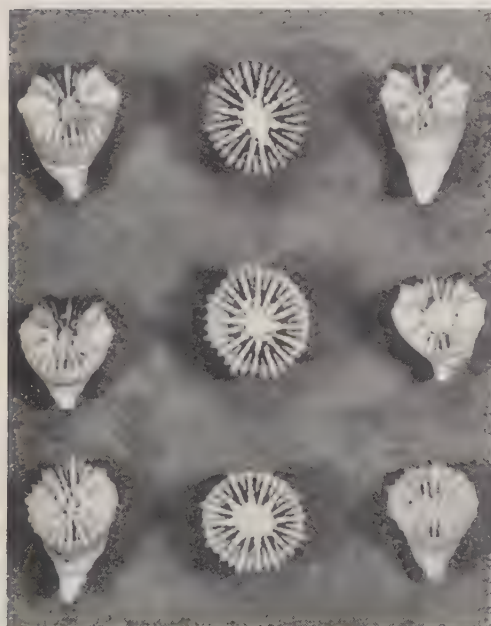
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DESCRIPTION OF PLATE III.

FIG. 5.—*Paracyathus gardineri* Vaughan. $\times 2.4$.

FIG. 6.—*Caryophyllia mabahithi* n. sp. $\times 1.3$.

FIG. 7.— „ *scobinosa* Alcock. $\times 1$.



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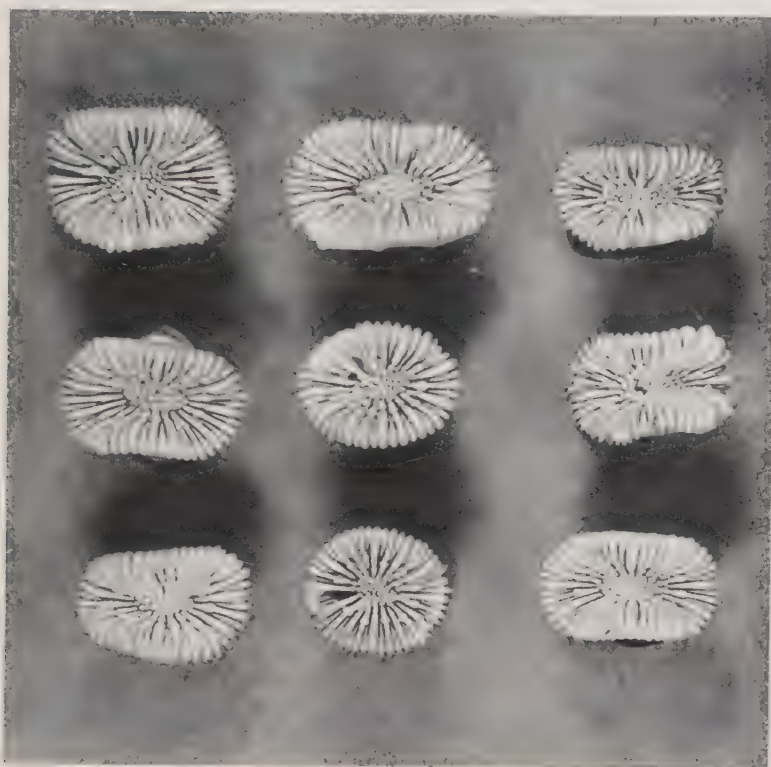


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DESCRIPTION OF PLATE IV.

FIGS. 8 and 9.—*Paracyathus conceptus* n. sp.

(Fig. 8 magnified and Fig. 9 reduced; see measurements in text.)



8



9

DESCRIPTION OF PLATE V.

FIG. 10.—*Tropidocyathus nascornatus* n. sp. Slightly magnified.

FIGS. 11 and 12.—*Conotrochus brunneus* Moseley. $\times 1.3$.



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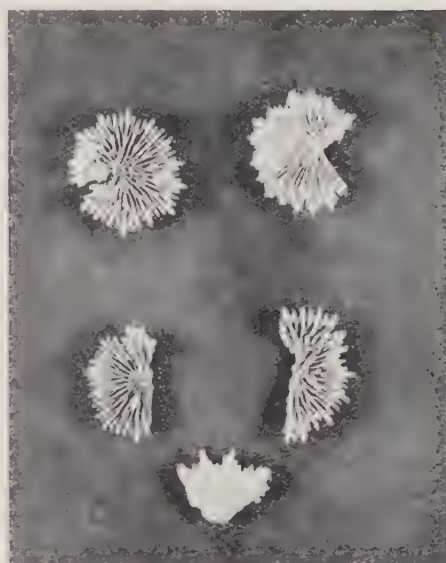
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DESCRIPTION OF PLATE VI.

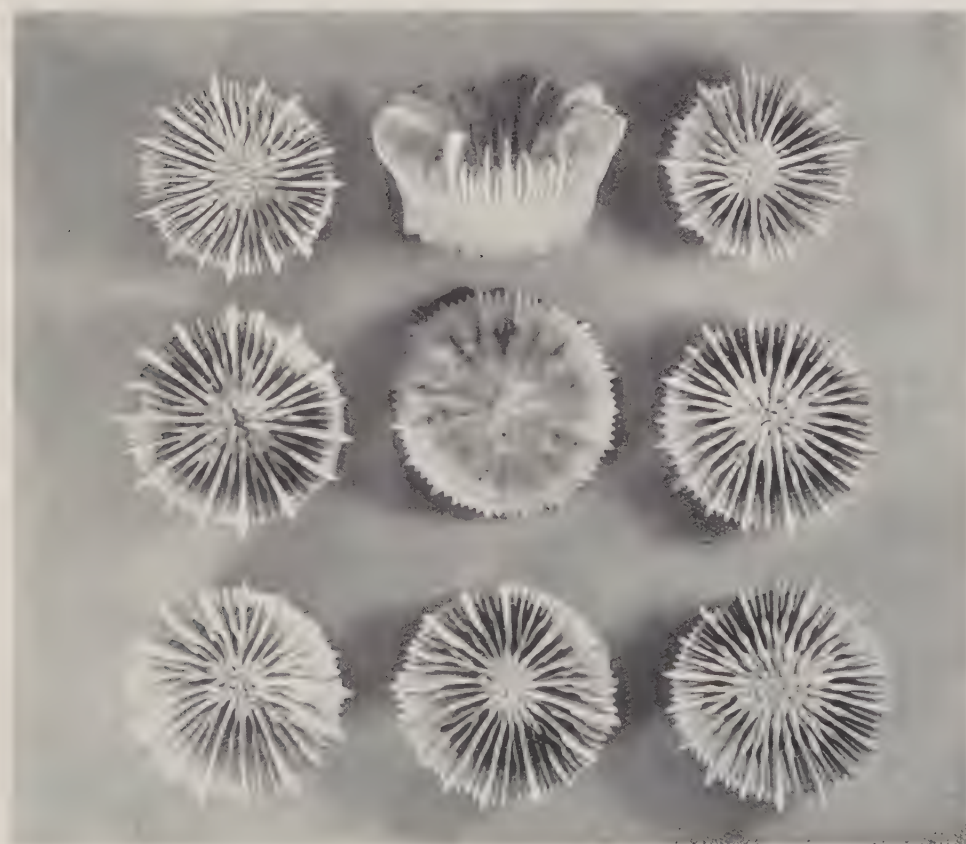
- FIG. 13.—*Stephanocyathus nobilis* Moseley. $\times 1.4$. Young forms, that to south-east St. 152, rest from St. 118.
- FIG. 14.—*Deltocyathus varians* n. sp. $\times 1.2$. The specimen to north-west is shown in Text-fig. 6.
- FIG. 15.—*Stephanocyathus nobilis* Moseley. $\times 0.8$. Adults.



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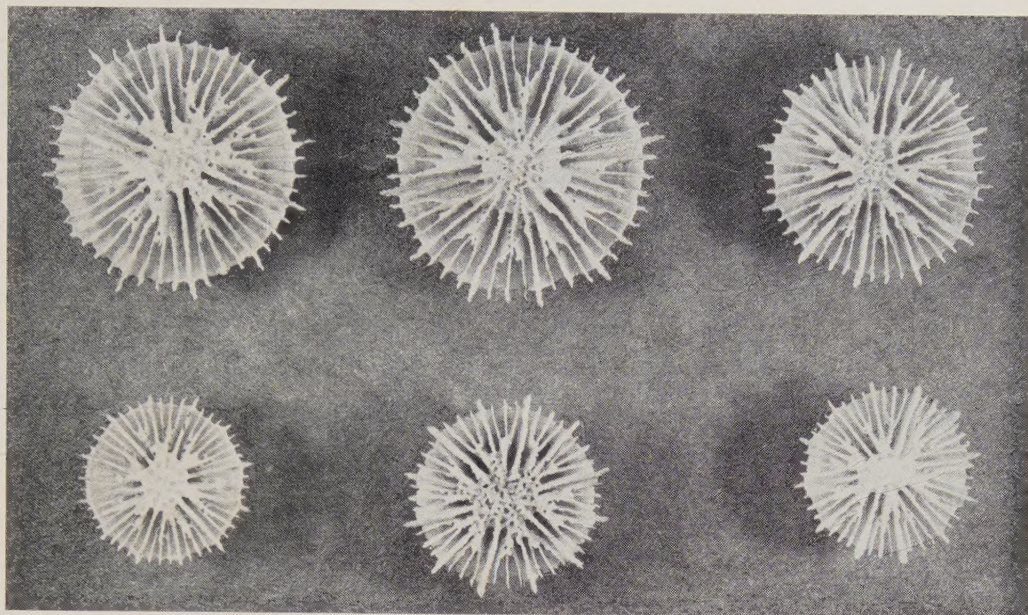
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DESCRIPTION OF PLATE VII.

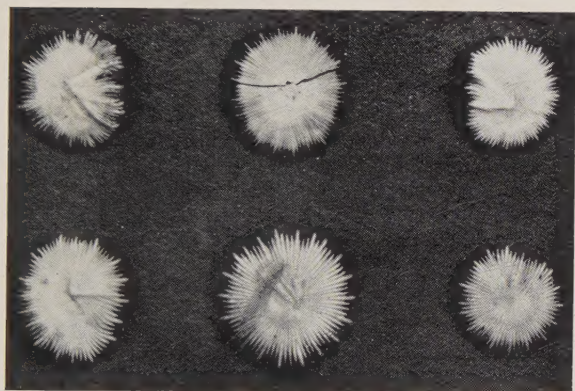
FIG. 16.—*Deltocyathus murrayi*, n. sp. $\times 1.8$.

FIGS. 17 and 18.—*Fungiacyathus sarsi* n. sp. $\times 1$. Five of these corals show on their underneath sides when magnified the sectors from which their discs were regenerating. The sixth was broken as shown here while still held together by polyp-tissues, in this resembling Sars' specimen.

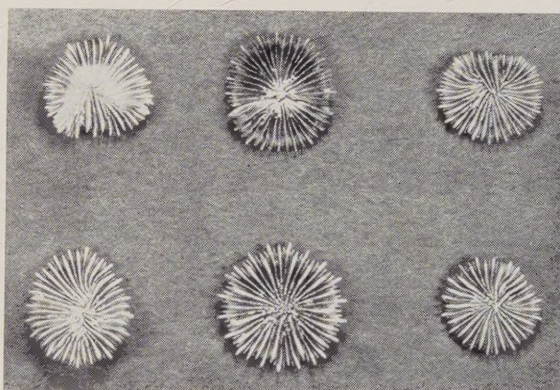
FIGS. 19 and 20.—*Fungiacyathus nascornatus* n. sp. $\times 1.8$.



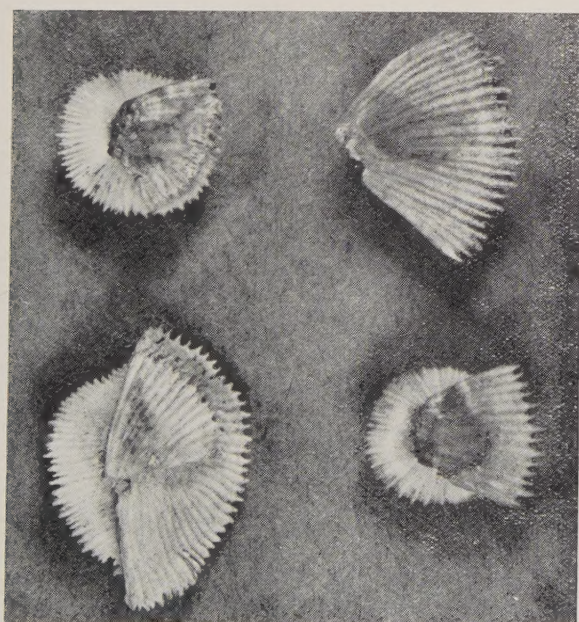
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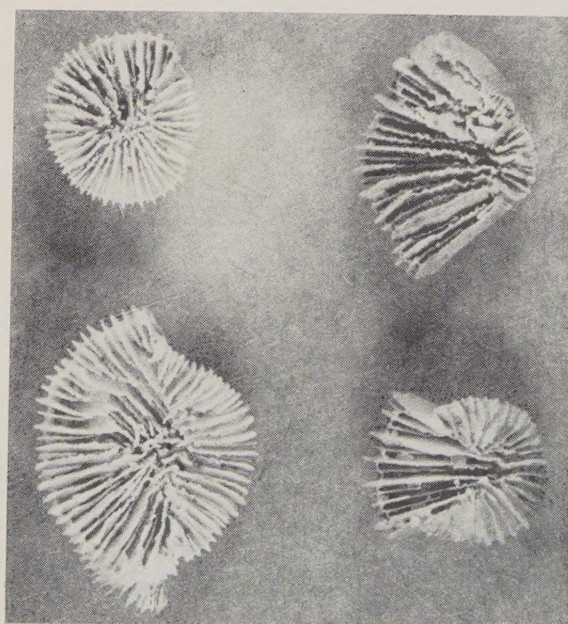
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